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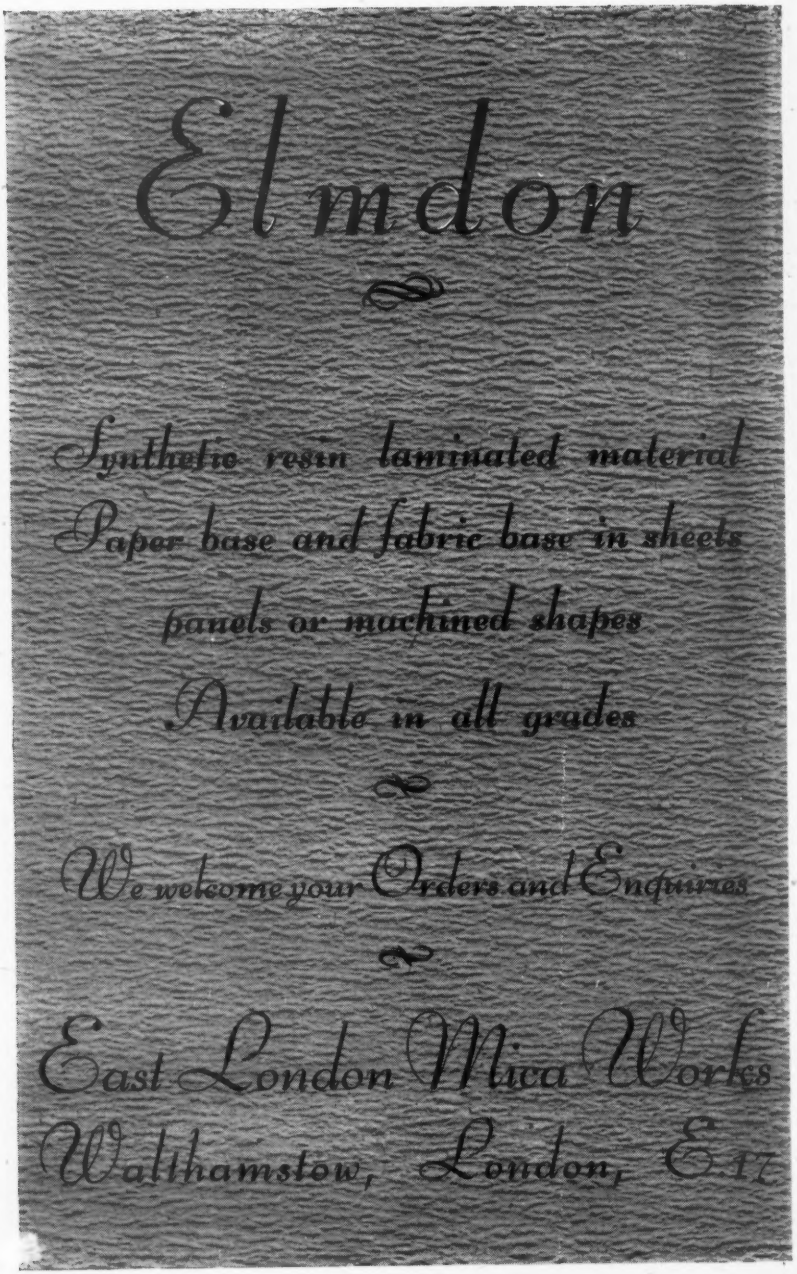
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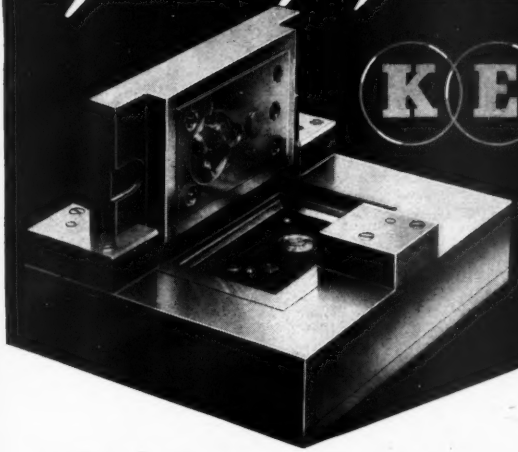

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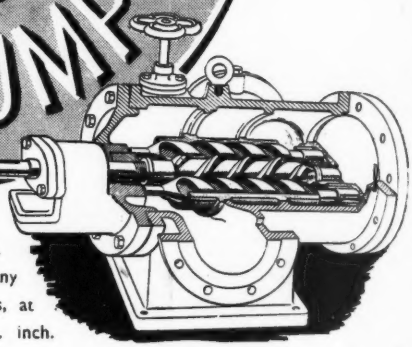

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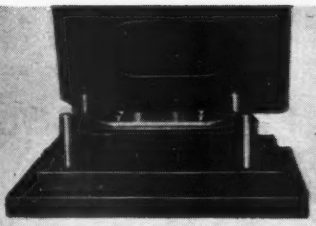

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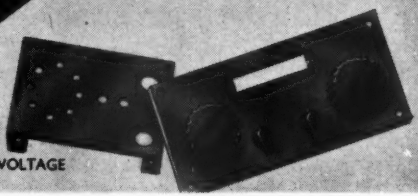

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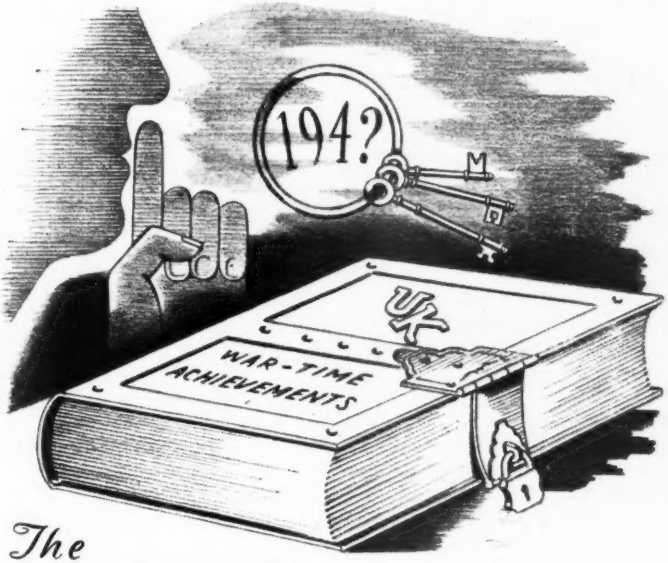

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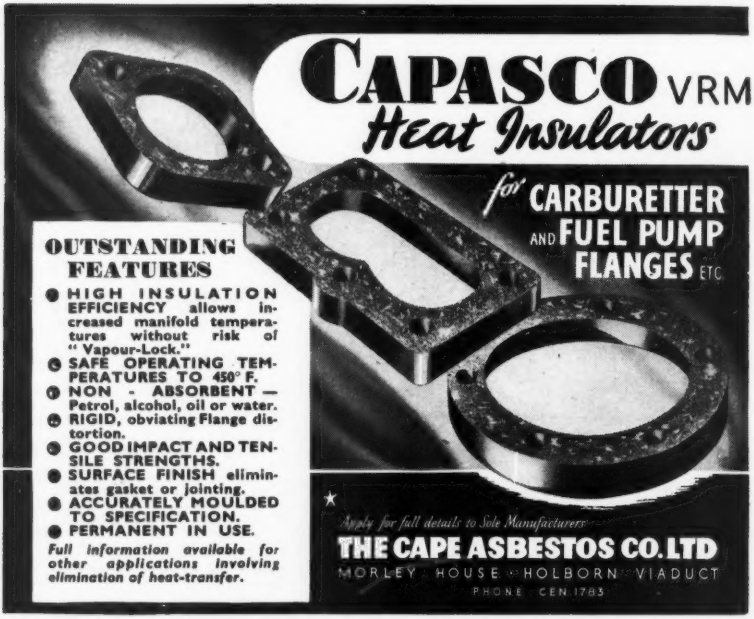
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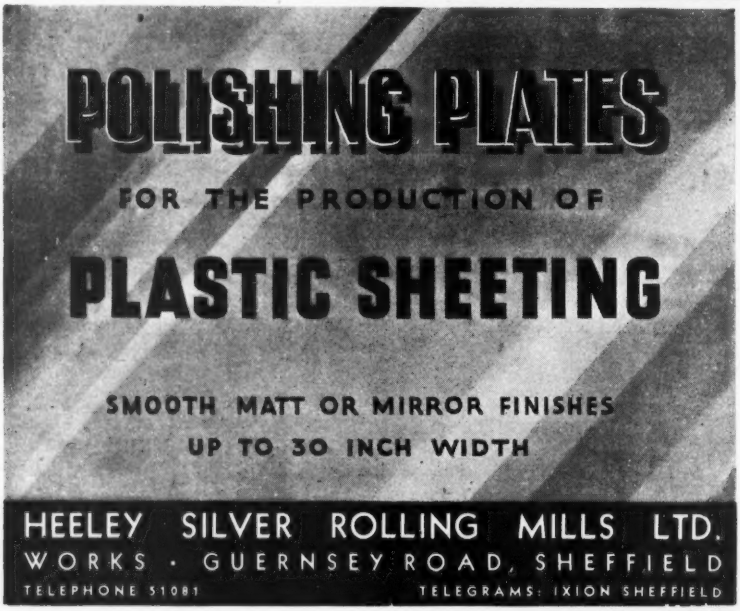
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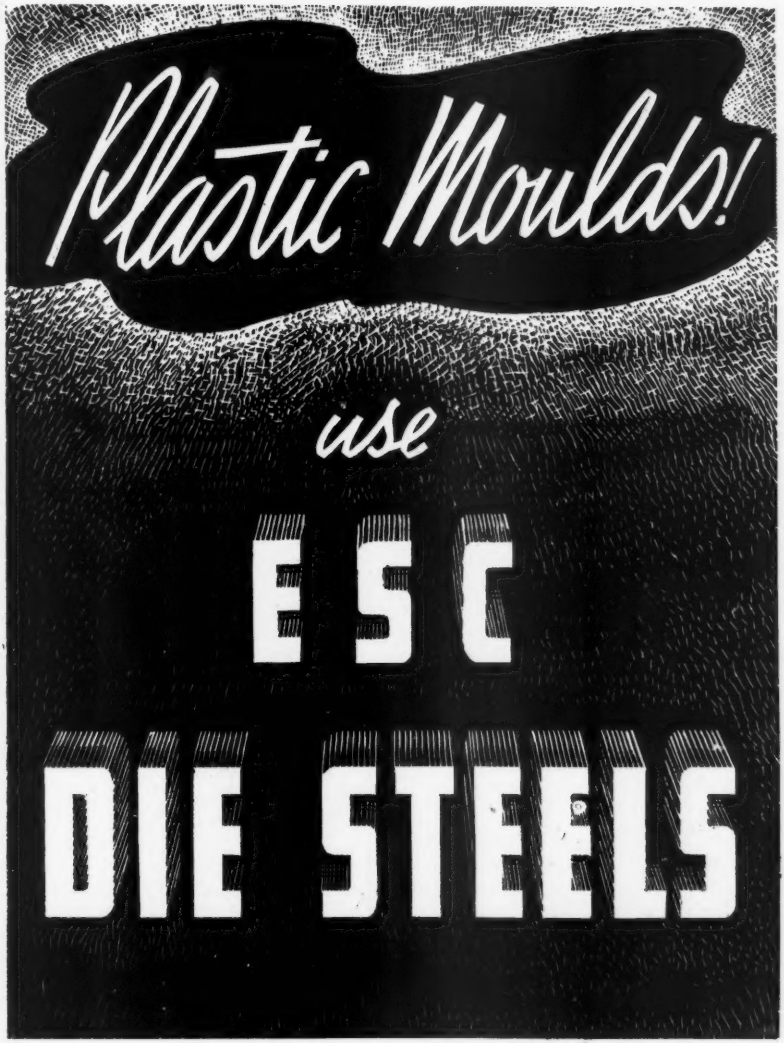

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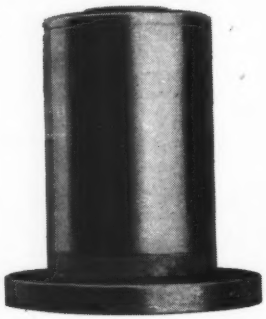

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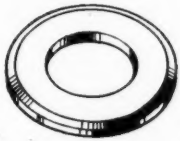

No. 352. BEVELLED ALL WHIT SIZES.

No. 352. PLAIN.

No. 554. ROUND. HARDENED AND TEMPERED DOMED.

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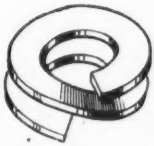

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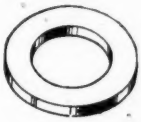

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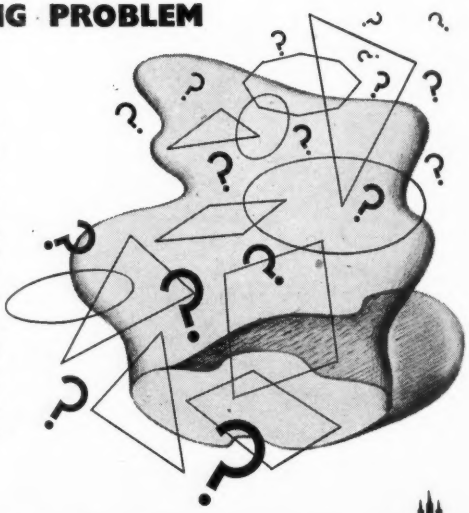

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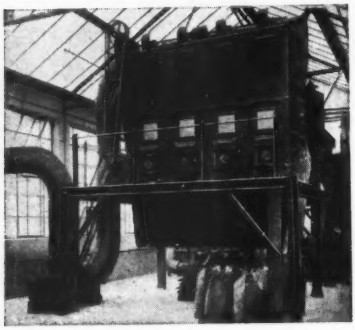

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Alice in Plasticland—No. 12

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ELO

PLASTICS

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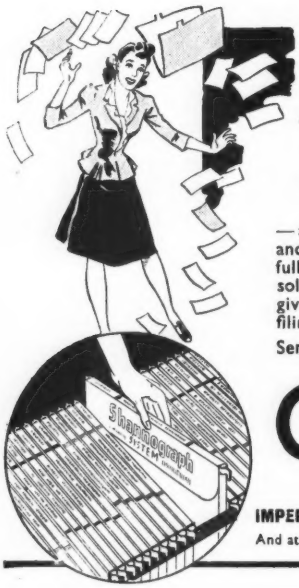

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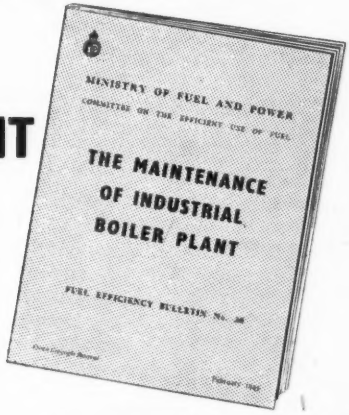

Fuel Efficiency Bulletin No. 38—"*The Maintenance of Industrial Boiler Plant*" offers under one cover much useful information. It not only lists many common and uncommon maintenance problems, but describes how to deal with them. It is a handbook for the man on the job—it is up to management to see he gets it.

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Vol. IX. No. 95 APRIL, 1945

Plastics

Dealing with the Manufacture, Uses and Potentialities of Plastic Materials

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CONTENTS

	Page
Editorials	154
Radio Components Exhibition	157
Melamine Plastics, by E. E. Halls	159
More British Plastic Tools ..	174
World's Industry Employs Plastics	176
Preformed Plastics	179
Resin Treated Plaster of Paris, by H. C. Bryson ..	181
Income Tax and Scientific Research, by J. Lymester	183
Testing of Plastic Bearings	185
Production News	190
Planned Mould Maintenance (Part XII), by W. M. Halliday	192
Resinoids and Other Plastics as Film Formers, by B. J. Brajnikoff	200

NOTICES

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SAVE PAPER

More than ever is paper waste required for our war industries. Waste paper makes munitions in a hundred forms—from shell cases to aeroplane parts.

The fact that goods made of raw materials in short supply because of war conditions are advertised in this journal should not be taken as an indication that they are necessarily available for export.

EDITORIALS

Death of a Colossus

WE are watching the end of a war. If we look closer amidst its fog we can discern the death-throes of a Colossus—not the German nation, for that will live if it can in time but learn the decencies and values of all human life—but the Chemical Colossus, that once ruled so much. It is dying, never to rise again we hope, at least in its old form.

As the Allied armies smash through and engulf the whole eastern bank of the Rhine and beyond, we, for our part, will remember those 200 miles of it from Essen and Duisburg, through Dortmund, Dusseldorf, Cologne, Coblenz, Mainz, Frankfort, Darmstadt, Ludwigshafen and Mannheim down to Karlsruhe. What a vast collection of chemical factories there was here bordering on the Rhine, the river that served them not only as a highway amongst themselves, but also as a gateway to the markets in the outside world.

It was this great manufacturing region that was at once the nerve centre and pumping station of Germany's industrial effort: her vast steel and coke-oven works, many of her explosive factories, her fuel-producing centres, her phenol and formaldehyde resources, her ammonia and nitric acid producers, her solvent and auxiliary plants, her fine-chemical works, her polymerization factories and, by no means least, her centres for producing chemical plant.

We know now full well how all this stupendous source of energy and products was turned on eagerly to supply not the legitimate needs of a nation in distress, but the sinews of a forthcoming war—the supplies for a Four Years' Plan that was to make Germany in the short space of four years independent of those raw materials which must come from abroad: copper, nickel, rubber, fats and drying oils, petroleum, mica, cotton and wool, so that a recurrence of the 1914-1918 blockade could not harm her. Steel, aluminium and magnesium, and her chemical and plastic factories were to do the trick. So far as the last-named industry is concerned, Wilhelm Pansegrau, in his "Deutsches Jahrbuch für die Industrie der Plastischen Massen," 1937/1938, and Richard Lepsius in his "Kunststoffe-Wegweiser" told us clearly how it was to be done and of the role the plastics industry was to play in the whole scheme.

Well, in the end it did not come off. Nothing came off, because of the steadfastness and faith of the nation they hated, despised and feared most of all.

There was much to admire in the old German chemical industry. They learned more from us and the French in pure chemistry than we learned from them in the 18th and 19th centuries, but it was we who learned from them on the ways of industrial chemistry in the 19th and 20th centuries.

We lived to see great good come from it, but in the end it served the most evil of masters believing, like most of the German nation, that it would rule the world and "swim in fat."

Now this vast engine of prostituted science lies a mass of tangled ruin and charred desolation. So let it lie.

Plastics at War

ON March 20 we listened with enormous pleasure to Mr. N. J. L. Megson telling us what this country has done during the past five and a half years to supply the Services with their requirements of plastics; so, too, did the largest crowd of plastics technologists and business men that ever crowded the Waldorf Hotel.

Mr. Megson, who in pre-war days under Professor Gilbert Morgan had done so

much for plastics both on the purely scientific and the technical sides, was one of the more fortunate choices among the "chosen instruments" collected together to make up the Advisory Service on Plastics at the beginning of the war. That he holds now the chief post in this Service is a direct measure of his value and the esteem with which he is held in the industry.

When we look backwards from the comparatively comfortable situation in the industry which exists now, and knowing the smoothness with which the wheels are turning, to those early days, most of us will remember the apparently appalling task that faced the British Plastics Federation, the Plastics Control Section of the Ministry of Supply, and the Advisory Service attached to it.

How many of these difficulties were overcome is Mr. Megson's story. He told of the beginnings of the Advisory Service; how it worked in advising the Services of the appropriate materials to use in the face of shortage of metals and other materials; of the best plastics to employ for entirely new projects which were being called for by Navy, Army and Air Force; of the building up of the essential standard specifications in collaboration with the British Standards Institute and the plastics industry itself; the devising of special moulding powders where the finished moulding had to withstand special and hitherto unknown chemical contact; the suggestions of new designs; the creation of a liaison with American workers in the same field —the work seems without end.

The lecturer also described the trials attendant on increase in the production of the raw materials of our industry under threat of bombing, of the difficulties of introducing new types and of overcoming them, and explained why it had been considered proper to decide on importing some plastics from America, and why they could not reasonably be made here.

He showed some strange lantern slides, but the climax of the evening arrived when we could examine the scores of mouldings in thermosetting and thermoplastic resins, extrusions and forming jobs which make up so much of our Service equipment. They were a credit to a very fine industry.

We can begin to congratulate ourselves that those organisms, the British Plastics Federation, Plastics Control and the Advisory Service, have together welded the plastics industry into a coherent form that will work together in peace in the same spirit that it has done in war.

There is much work ahead for it.

Round Figures and Square Figures

IN the March issue of this journal we made an appeal for the divulgence of our production figures in the plastics industry, and we must admit we went to hear Mr. Megson's paper, which was delivered with the permission of the Government, that is, the Ministry of Supply, in the hope that it would include some. We were disappointed, although Mr. Gibson, who spoke afterwards, aroused our hopes once, but, unfortunately, only a round pre-war figure was given.

Mr. Megson would, no doubt, protest that his department is not concerned with quantity but with quality. This is true, but he did, after all, present a paper entitled "Plastics at War"; and one of the most important points about an industry during war-time is the quantity it produces. At a time when the war is in its closing stages it is essential to tell the world what has been done. Such figures would have made the lecture complete and would have greatly enhanced its value, internationally speaking.

Moreover, Mr. Megson did talk about the production of plastics, but his words were merely the usual vague ones, "large quantities were produced," "considerable production," "manufacture was increased," expressions which are not of much value. Yet he knows the real production. Why all this shyness?

We talk glibly and with confidence on technical exactitudes, yet we cannot tell the world we are large producers of plastics. So far as most foreign countries

are concerned there seems to be an amiable conspiracy to maintain the belief that the U.S.A. is not only the largest producer in the world, but also the only one.

Of course, our figures are much smaller than those of America, but they are, nevertheless, very substantial.

This secrecy does seem to go back to the bad old days when manufacturers wanted nobody to know anything at all about their businesses.

Sometimes this reticence reaches absurd limits, as, for example, in a description of the production of polythene in our last issue; the author stated that the British plant now manufactures 2,000 times the production of 1938, without saying what "x" was. We can be fairly sure that the pilot plant produced more than one ton in that year, but if it had been 10 tons we should have been more pleased, since 20,000 tons a year for present production is big, even for the U.S.A.

We are also reminded of Mr. H. V. Potter's paper on "Post-war Planning." In it he said:

"I have tried to figure out the extent of our responsibility, but there are no figures available to me. Taking plastics material manufacturers, that is, the people who make the materials that many of you people use, from information I have, I estimate that we are at present employing about 8,000 operatives. If you add to this the supervisory staff, there is, we can assume, about 10,000. That is based on a certain amount of information that I have, and it looks as if it is about 10,000 in all, which is not very large.

"The moulding industry and the other branches of the plastics industry, taking the laminators, moulders, fabricators, and people who are classed as in the plastics industry, I figure employ about 30,000 to 40,000, and with supervisory staff approximately 50,000. I do not see at the moment that this industry is employing more than about 60,000 to 70,000 people."

With the best will in the world, we cannot describe this as anything but a lamentably vague statement. This is not Mr. Potter's fault, but his position in the industry is sufficiently great to question a recent pronouncement by Mr. Brenden Bracken that the plastics industry now employs 100,000 workers.

Why cannot we have square figures?

American Substitutes Exhibition

On Tuesday, March 27, this exhibition at Berkeley Court, Baker Street, W.1, which has been kept "secret" for over three years, was thrown open to a few representatives of the Press.

In the past only Service experts and industrialists have been allowed, by special pass, to study these substitute materials lent by the United States in order to study British production of Service equipment.

Some of these substitutes had already been evolved in a like form in the United Kingdom, but we naturally welcomed an opportunity to study the latest American developments, particularly in view of our war-time limitations on their manufacture. For this and other reasons Britain has not been able to provide a comparable exhibition. At the present time there are between 1,200 and 1,500 exhibits. These cover paper packing materials and fibrous products, a wide range of plastic products and processes, glass, textiles, pharmaceuticals, metals and leather.

Polyvinyl Chloride Scrap

A fair amount of polyvinyl chloride scrap has always been available from the cable, sheet-using industries, etc., and is being bought and used for a variety of non-priority purposes by some concerns.

The scrap is reprocessed, sometimes with the addition of plasticizer, and re-formed into sheets for cutting. Generally speaking, this is a sensible use of such "waste," but this treatment may possibly come under suspicion in certain circumstances.

For example, phthalate plasticizers are now unfortunately, as rare as snow in Nigeria, and no doubt recourse is made to other types. The former types have, so far as we know, a clean bill of health from the toxic point of view, whereas some of the other commonly known plasticizers have not. The point of this note lies in the fact that certain manufacturers are putting tobacco pouches and, what is more important, waterproof bed sheets for children, on the market, and it would therefore seem advisable that these manufacturers should convince themselves that the plasticizers they use are not suspect.

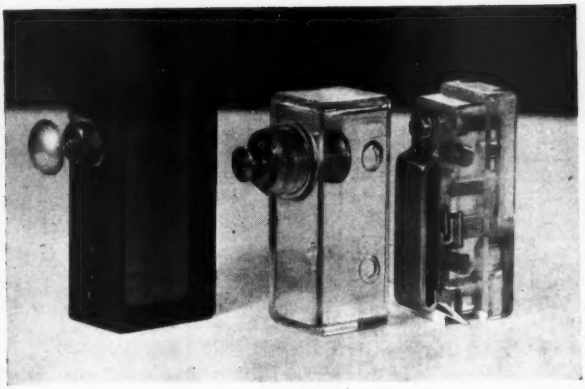


Fig. 1.—Pye switch with (on right) Perspex exhibition model.

The Radio Components Exhibition and Plastics

THE emphasis at the Radio Components Exhibition (held at Grosvenor House on February 20-22) was on the development and production of equipment suitable for use in tropical and sub-tropical climates, and plastic materials were much in evidence on most of the 90-odd stands.

Specially developed moisture-resistant mouldings were shown as part of completely assembled switches and variable-resistance gear. Two examples are shown in Figs. 1 and 2. The first illustration shows a plunger-operated switch, developed by Pye Radio, Ltd. The exhibition model, which is shown in the picture, is totally enclosed and sealed in a Perspex cover. The standard range, however, is made up with a black moulded phenolic resin housing.

This switch, which is also fitted with a synthetic-rubber protective cowl over the plunger, measures only 2¼ ins. by 1⅛ ins. by 1 in. approximately, excluding the plunger, can carry 5 amps. at 250 volts (A.C.), and weighs only 2¾ ozs. It is completely sealed against oil, petrol and water.

The second photograph shows a sectional view of the well-known Morgan tropical potentiometer. This component has been extensively tested in tropical conditions. The overlapping parts of the moulded cover are shown quite clearly in the photograph, and a special sealing

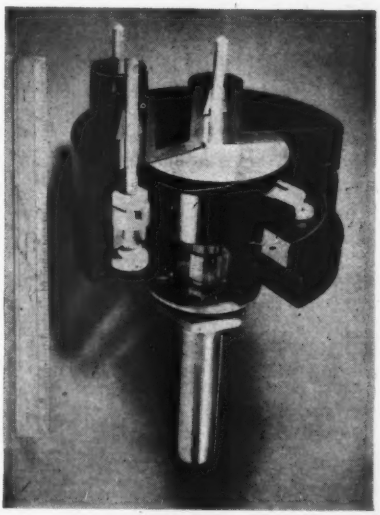


Fig. 2.—Variable resistor by Morgan Crucible Co., Ltd.

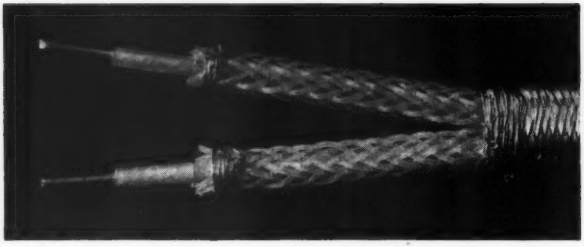


Fig. 3.—New high-frequency cable by Tenaplas, Ltd. In this type the amount of material used is kept to a minimum. The cable is more flexible and less susceptible to cracking.

(Photographs courtesy Tenaplas, Ltd.)

compound prevents moisture seeping in through this unavoidable joint. The internal metalwork is also protected against corrosion, and the moulding compound used is specially selected for use in humid atmospheres.

Polyvinyl-chloride products were very much in evidence as extruded sleevings and wire-covering compounds. Sheet products were also shown on some stands. Seven different firms were exhibiting extruded sleeving of the vinyl types. It is not surprising that these stands attracted so much attention, because, as reported in a recent article in this journal (Tropic Proof Wiring, February issue, 1945) plastic sleeving has been shown to be superior to many other types for use in tropical and humid atmospheres.

Polythene products were more numerous than at last year's exhibition. Injection Moulders, Ltd., showed a variety of products in polythene, including an injection-moulded spherical aerial housing, which, made in two halves of 3-32-in. thick material, was approximately 5 ins. in diameter.

Other examples of work in polythene were shown on the stand of Tenaplas, Ltd., who also exhibited P.V.C. sleeving of all kinds and P.V.C. sheet material of various thicknesses. The polythene products on this stand were all high-frequency cables with polythene as the dielectric. In the February issue of "Plastics," readers will have noted that Mr. P. C. Allen, in his article on the "History of Polythene," remarks about the use of polythene for H.F. cables in the early days of the war. On the Tenaplas stand a good many of these special cables were shown and also a new type of low-loss cable developed in the firm's research laboratories. Interwoven filaments of extruded polythene are used in this cable to increase the efficiency of the cable insulation at very high frequencies. The new cable is shown in Fig. 3.

On the stand of the De La Rue (Plastics) Company, a number of samples of the work of the Universal Engraving Co., Ltd., were shown. This company specializes in engraving on plastics. Complete wiring diagrams of radio equipment were shown, executed in black and white on phenolic laminated sheet. One of these, quite a complicated job, measured nearly 18 ins. by 12 ins.

A new use for Neoprene was shown on the stand of one of the firms making tubular capacitors for use in very arduous and extreme tropical conditions. These capacitors are enclosed in a tubular metal can, with an end seal made of Neoprene. The lead-out connecting wires come through the Neoprene without providing a way which moisture could penetrate through to the paper and foil element inside.

Almost all of the exhibitors had on view radio components constructed with plastic materials either in moulded or sheet form, and after an hour or two at the exhibition, which was run privately by the Radio Components Manufacturers' Federation, under the auspices of the Radio Industry Council, a visitor could not fail to realize the degree to which the radio industry and the plastics industry have co-operated throughout the war, and are dependent on each other for their joint prosperity in post-war years.

Melamine Plastics

By E. E. HALLS

THE melamine resins are thermosetting in character, and are formed by the condensation of melamine, which is a cyanide product, with formaldehyde. They are, therefore, somewhat similar in appearance and properties to the urea formaldehyde resins, over which they possess some advantages. From the melamine resins have been developed a range of commercial products akin to those derived from the better-known thermosetting resins, the phenolics and the ureas. Moulding powders, laminated sheet products, adhesives, varnishes and treated papers are included in this range. These materials possess some advantages over the corresponding urea products, and, in fact, in some instances over the phenolics. Although they are not very well known in this country, they are already widely appreciated in America, and have been quite extensively used on the Continent, particularly in Germany. Some information from these sources is of interest in preparation for the time when users in this country are freer to give consideration to such newer products.

The American Cyanamid Co. of New York has been responsible for the development and manufacture of melamine resin products, and the following information, except where otherwise stated, is taken from their publication "Melmac Moulding Compounds."

The basic melmac resin in the uncured condition is a colourless glassy solid; it is fusible and partially soluble in solvents. Subjected to high temperatures, the resin undergoes a rapid chemical change and it becomes infusible and

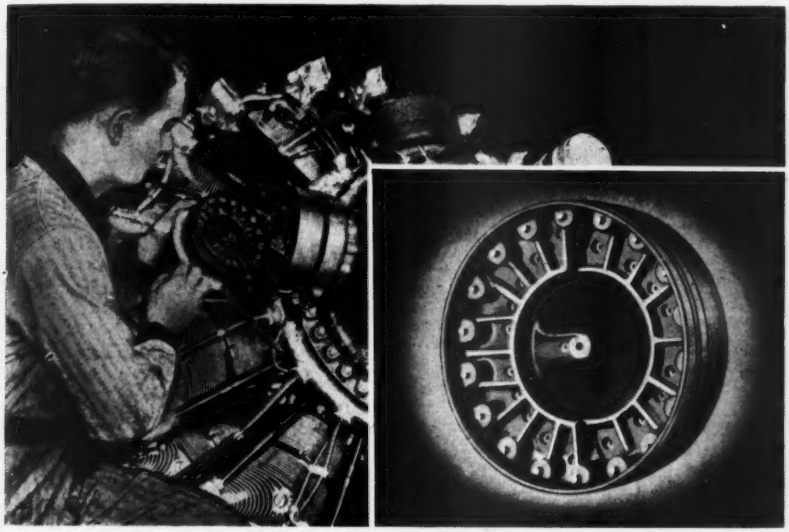


Fig. 1.—Melamine (Melmac) distributor used on 18-cylinder radial aircraft engine. High arc resistance and dielectric strength of these mineral-filled melamine resins make them very suitable for this application.

Fig. 2.—Examples of the melamine resin harness parts for a Rolls-Royce Merlin aircraft engine.

insoluble, and the product is odourless, tasteless and, in general, chemically inert, thus the melamine resin is a thermosetting or heat - hardening material.

In the uncured condition the melamine resin can be used for producing adhesive and varnish solutions. These solutions can be employed for the impregnation of papers and fabrics for the production of laminated sheet products, translucent or opaque varieties. They also serve as the adhesive bonding agent for plywood, as well as in general for the basis of adhesive solutions and stoving enamels or varnishes for metal-finishing purposes.

Again, the uncured resin in solid form can be compounded with the usual types of fillers, cellulose, chopped fabric and mineral fillers, to yield thermosetting moulding powders. Each of these types warrants separate discussion. They have possibilities in all fields on account of good mechanical strength, high dielectric strength and high arc resistance, and excellent surface hardness, with special aptitude for resistance to scratching. Fig. 1 shows one application which speaks for itself—the melmac distributor used on an 18-cylinder aircraft engine. Not only are the electrical characteristics of arc resistance and dielectric strength confirmed by the Services' adoption of this plastic in this critical application, but also the dimensional stability and inertness, and mechanical strength in all respects, are demonstrated.

Melmac 1077 is a melamine resin moulding material having alpha-cellulose as filler. It is similar in appearance to beetle moulding material. The basic resin is colourless, and the cellulose filler is a pale white. Therefore, the moulding compound in its unpigmented condition yields pearl white, translucent mouldings. By suitable choice of dyes and pigments, and their incorporation in the moulding composition, a range of coloured mouldings in opaque or translucent forms can be produced. These have a colour fastness dependent only upon the dye or pigment incorporated in the moulding powder.

Melmac 1077 is claimed to be superior to the beetle urea products in that it possesses greater water resistance, better resistance to staining by food, better resistance to abrasion, to acids and alkalies, and superior heat resistance. This superiority has been demonstrated in service by commercially moulded buttons and tableware, both of these applications having been approved for the Services.

Melmac 1077 moulding powder is supplied in lever lid composition drums, normally 200 lb. net, and the only real requirement for storage is a cool, dry location. Cold storage and cold are both advantageous in so far as they protect the composition against change in flow characteristics; but when used in the moulding shop it has to be remembered that, for best moulding conditions, the material

should be at least at room temperature before placing in the die.

Melmac 1077 can be pre-formed on all automatic machines which are suitable for the tableting of urea and other thermosetting moulding compositions, and it is found that the cohesiveness of the melmac is equal to that of other moulding powders. The dies should be polished by lapping rather than by circumferential polishing, as this permits of easier ejection of the preforms. Again, the preform dies should have a taper of 0.002 in. per inch of depth, with the maximum opening at the top of the die. The density of melmac 1077 is higher than that of the beetle moulding powder made by the same concern. Comparative values are given as 65 to 70 for the current melmac 1077 range, against 55 to 65 for the beetle, and these have to be taken into account when adjusting tablet-weights.

It has been shown from experience that to prewarm the melmac 1077 moulding powder is advantageous, because thereby many of its properties are improved and the production cycle can be accelerated. Compared with the beetle urea moulding powder, a longer period of prewarming can be tolerated, and this operation is not so critical. Best results are obtained when the powder is charged into the mould at 180 to 190 degrees F., this holding good whether the prewarming device is of oven type, platen type or any of the other modern methods used for similar thermosetting moulding compounds. In general, oven temperatures of the order of 220 to 240 degrees F. are advocated, and are preferred to using shorter times at higher temperatures. However, correct relationship between the oven temperature, agitation of the moulding powder, and the mass of the latter to be heated has to be afforded sufficient study in order to derive maximum benefit from any prewarming facilities.

It seems evident that prewarming should be resorted to because the conditions imposed are not critical, yet the process ensures that the ultimate level obtainable in electrical and physical properties is secured. Further, components produced are of better appearance, and gas and flow marks are more readily eliminated.

Melmac 1077 remains plastic in the mould for a longer period than does beetle urea, and this extended period of flow of the melmac material obviously allows of greater flexibility in moulding. On the other hand, it sets up in the mould more rigidly than does beetle, and, therefore, for ejection of the component, either a greater pressure is needed or a greater mould taper and polish must be provided. Chromium-plate finish to the moulds is advocated whenever practicable, as it not only facilitates ejection but assists in ensuring the best possible finish.

Regarding flow range, melmac 1077 is marketed in flow ranges approximately the same as for beetle urea powders, and selection can be made of a powder of appropriate flow number without any fear of adverse influence upon the properties of the moulded article.

The temperature range for the moulding of melmac 1077 is 300 to 345 degrees F. with large articles and heavy sections processed at the lower end of this range, and small items such as buttons at the higher end.

The following information serves as a guide to moulding conditions. The manufacturers advise for large pieces having a draw that the powder be prewarmed or preheated and breathed. When the draw is short, 2 ins. or less, a short preheat of 10 to 20 seconds and a short breath of five to 10 seconds towards the end of the cycle result in good components. For longer draw pieces, prewarming is more satisfactory. A moulding temperature of 300 degrees F. ± 5 degrees F. has been found to be the optimum for pieces of long draw. At this temperature of 300 degrees F., the cure time for optimum resistance to water and to cracking is 2½ to 4½ minutes on a section of ⅛-in. thickness, including the cycle.

On components with little or no draw the moulding pressure ranges from 2,000 to 4,000 lb./sq. in. For draw pieces the pressure required can be derived by add-

Table 1.—Approximate moulding conditions of Melmac 1077.

Part	Area	Draw, in.	Thickness, in.	Parts/LB	Mould Temp. °F.	Pressure per cav. tons.	Cure	Type of Mould
Buttons	⅛ in.–2 ins.	—	⅛	300–1,000	320–345	½–2	½–1 min.	Flash
Buttons	¼ in.–2 ins.	—	¼	80–300	300–330		1–2½ min.	
Tableware								
Cups	5–8	3–5	3/32	6–10	310–340	15–30	1–3 min.	Semi-positive or loose positive
Plates	30–80	1	3/32	3–8	310–340	40–100	1½–3 min.	

ing 700 lb. per sq. in. to the basic pressure of 2,000 to 4,000 lb./sq. in. for each inch of vertical draw.

The melmac 1077 materials so far developed are recommended only for compression moulding.

Well-cured products show no surface attack or loss of gloss after boiling for 10 minutes in a solution of sulphuric acid in water, concentration of 1 per cent. of weight. Components indifferently cured exhibit a satin-like or chalky finish when tested by this method.

A numerical guide to moulding melmac 1077 is given by the tabulated data for approximate conditions given in Table 1.

For finishing moulded components, the same technique as are used for beetle urea mouldings may be applied.

The attractive commercial field for melamine alpha cellulose-filled mouldings embraces applications in which bright colours, resistance to boiling water, to staining and to abrasion, are primary features. Buttons withstand very severe laundering conditions and tableware withstands arduous conditions of staining and washing. Melmac 1077 is superior to beetle urea in these applications.

Mineral-filled Melamine Moulding Compounds

The mineral-filled variety of melmac moulding compounds are designed in the first instance for industrial applications in which electrical requirements of arc resistance and good dielectric strength and where heat resistance are qualities of primary importance. It is claimed that higher arc resistance is obtained than with any other synthetic plastics available. Outstanding properties over a wide range from high to low temperatures (400 degrees F. to − 40 degrees F., 205 degrees C. to − 40 degrees C.) render mineral-filled melmac mouldings suitable for use in aircraft, automotive and traction ignition components and for electrical appliances such as circuit breakers, terminal blocks and electrical control apparatus. Lower water absorption is said to be one obviously advantageous property which renders these mouldings little affected by weather conditions, and high humidities exert little or no adverse influence upon electrical insulation qualities.

Several grades of mineral-filled melmac moulding compounds are available to meet specific needs, and data covering their physical and electrical characteristics are given in the appended tabulated information.

Brief notes upon the preparation, moulding and finishing of the mineral-filled melmac compounds are given in the following.

A range of plasticities is available. An extremely soft flow is satisfactory for intricate transfer mouldings. An exceedingly hard flow can be used for small compression moulded components. The

Table 2.—Flow Ranges of Mineral-filled Melmac Moulding Powders.

Flow	General Plasticity	Type of application
P.S.I. 250–350	Very soft	For large, intricate mouldings, generally transfer moulded.
P.S.I. 400–600	Medium	For general purpose transfer or compression moulding.
P.S.I. 650–800	Hard	For compression moulding of relatively small, simple parts.

variable requirements of other articles can be satisfied with grades of intermediate flow values. The soft flow grade flows at about half of the pressure required for the softest commercial phenolic or urea materials.

Table 2 summarizes the typical flow ranges in which the mineral-filled melmacs are produced, and it is stressed that the properties of the finished components are not dependent upon these plasticity values.

The mineral-filled melmac compositions are supplied in airtight containers of 250 to 300 lb. contents. Stability is good when compared to the urea compound, but storage should be under cool, dry conditions. This ensures retention of the original moulding properties of the powder and the corresponding good qualities in the finished product. The powders are provided in granular form and can thus be readily charged into the die by normal bulk-loading methods, and are easily adapted to manual or to automatic preforming methods.

For preforming the mineral-filled melmac compositions, highly polished or chromium-plated preform dies are advocated, because with all grades more pressure is needed for ejection. The polishing of dies should be achieved by lapping and not by circumferential polishing. Tapered preform dies are essential, with a taper of 0.002 in. per inch of depth, with the maximum opening at the top of the die.

The precaution of rolling full drums of moulding powders before use is recommended to assist in assuring closer weight control of tablets. Another practical hint is to incorporate from 1 to 2 per cent. of zinc stearate per pound or two of the material which is first passed through the machine. Operations are said to be greatly facilitated by this procedure. These first preforms can be used to "break-in" a new mould, and the moulded parts then discarded. Supplementary lubrication of these materials is not recommended and, beyond certain limits, valuable properties in the compound are endangered.

Large and intricate mouldings are produced by compression and by transfer methods, depending entirely upon the design of the component. The physical and electrical properties of the component are said to be independent of the moulding method used.

Hardened steel moulds of the type and design normally used for other thermosetting compounds are satisfactory. However, it is necessary to check individual dimensions in order to determine whether the shrinkage allowance calculated for other materials is correct for the mineral-filled melmac composition. The use of an experimental die is advocated at the start of a new job. In this way a more accurate determination may be made of the tolerances and shrinkage allowances that are necessary, because shrinkage may vary, depending upon the form of the moulded component.

As before stressed, mineral-filled plastics of all types must be run in highly polished steel dies, preferably chromium-plated. Ejection is facilitated and tool life is increased.

The following serves as a guide to the factors which determine whether a component should be moulded by transfer or by compression methods:—

(a) When close dimensional tolerances are to be maintained, transfer moulding is generally preferable.

(b) When large variations in cross-section of the component, or quite thick cross-section is involved, transfer moulding is preferred.

(c) When the pressure available is limited, compression is preferred.

(d) The location and type of inserts, and the design of the component, have a bearing upon the moulding method to be adopted. Inserts which are sturdy and well secured in a component which is not too intricate in design lend themselves to compression moulding. If the inserts are not well secured or are delicate and if the component is intricate in shape, transfer methods are frequently used.

(e) When an insert or core is supported between two halves of a mould and the mould must be closed to hold it in place, transfer moulding is preferred.

(f) When a mould consists of several loose parts that have to be clamped tightly together to prevent leakage of the compound during moulding, transfer methods are used.

Warning is given that with transfer moulding even a good weld reduces the strength of the moulded part. Mould gating must be arranged to avoid welds at critical points or sections subject to strain of either a physical or electrical nature.

If prewarmed, melmac mineral-filled compounds are more perfectly moulded. The closer that the moulding composition is brought to the mould temperature prior to loading into the die or pot the better will be the resultant component. Prewarming causes volatile matter to be driven off, and thereby physical and electrical properties are improved. The more volatile matter that is driven off by prewarming without affecting the final closing of the mould the better will be the insulations characteristics of the finished component.

For prewarming, oven temperatures of 200 degrees to 350 degrees F. can be used to give material temperatures of 160 degrees to 220 degrees F. The time period may be from 3 to 20 minutes, dependent upon the weight of powder heated.

One method of prewarming uses a rotary oven. The material is constantly agitated and is more uniformly prewarmed than in stationary ovens. The heating means may be electrical or steam; infra-red lamps can be used.

Another method uses tray ovens, likewise heated by electrical elements, steam heaters or infra-red lamps. The moulding composition should be spread thinly on the heated trays, and hot air circulation should be employed. Accurate control must be provided to avoid precuring. Thick tablets are difficult to prewarm in this manner.

High-frequency electrostatic preheating can also be used advantageously. Precuring must be avoided whatever prewarming equipment is used. It is recognized by the appearance of light-coloured or opaque spots on the moulded parts or by improperly filled mouldings.

Average mould temperatures are 285 to 300 degrees F., regardless of the method of moulding. Individual temperatures vary from 280 degrees F. for large, thick-sectioned parts, to 360 degrees F. for relatively small and thin-sectioned components. When short cures are required, for production reasons, higher temperatures up to 360 degrees F. are advocated to ensure maximum water and weather resistance.

Pressures for transfer moulding may range from 4,000 to 20,000 lb./sq. in. Simple components can employ the lower pressures, but large and intricate mouldings usually must be given the higher pressures. From 10,000 to 14,000 lb./sq. in. represents the average values used in transfer moulding.

Table 3.—Curing Time for Mineral-filled Melmac, 4 ins. dia. Discs at 300 to 310°F.

Cross-section	Compression	Transfer
¼ in.	2½ mins.	2½ mins.
½ in.	4–5 mins.	3–4 mins.
¾ in.	8–10 mins.	4–5 mins.
1 in.	12–15 mins.	5–7 mins.

For compression moulding, the pressure may vary from 1,000 to 6,000 lb./sq. in., dependent upon the size of the component and its draw.

Relatively simple moulding cycles are employed. Increased flexibility to them is given because of the slow set of the mineral-filled melmac compositions, so that they do not stiffen rapidly during the moulding operation. This permits of straight closing of the mould, whether compression or transfer methods are used. If gas marks, streaks or blisters result when prewarming, and straight closing of the die are resorted to, then breathing or preheating in the mould can be adopted to eliminate such faults.

Curing time at any given temperature is a function of the thickness of the com-

Table 4.—After-baking Conditions for Mineral-filled Melmac Mouldings.

Cross-section	Temperature	Baking time
⅛ in.	270°–300°F.	14–15 hrs.
¼ in.	230°–250°F.	24 hrs.
½ in.	200°–220°F.	24 hrs.

ponent. In Table 3 some data are given as a guide; they appertain to 4-in. diameter discs moulded at 300 to 310 degrees F. Properties of electrical insulation, dielectric strength, power factor and dimensional stability are improved by subjecting the components after moulding to a baking treatment. However, this must be carried out carefully because if either the temperature or time period is excessive cracking may occur through heavy sections or around inserts. The tabulated data given later show some of the benefits to be derived. A guide to the optimum temperatures and baking times for various thicknesses of article are given in Table 4.

The mineral-filled melmac mouldings are as simple to finish as are the other thermosetting mouldings. Small parts of simple configuration can be barrel-treated, but the normal sanding and grinding techniques can also be applied. After finishing to remove flashes, if the skin of the moulding has been damaged, polishing is resorted to if the maximum is required from the properties of the material.

The mineral-filled mouldings are more difficult to machine than wood-flour or alpha-cellulose-filled plastic articles, due to their more abrasive nature. Normal equipment may be used, but carbide-tipped tools should be employed on account of their longer life. Holes can be drilled satisfactorily. If heavy metal inserts need to be machined, care must be exercised because of the danger from the heat generated. Liquid coolants should be used freely.

Melamine Mouldings With Filler of Chopped Cotton Fabric

Melmac mouldings having chopped fabric as fillers are designed for industrial and domestic applications when resistance to shock has to be included in the qualities of the article. The domestic, or general, field uses these impact-resistant mouldings for shock-proof tableware and service trays. They have a hard, scratch-proof surface, are odourless and tasteless, little affected by boiling water or by staining, and they are very resistant to heavy abuse. Industrial applications include large circuit-breakers and heavy-duty handsets. Electrical arc resistance, resistance to fire and high flexural strength are primary reasons for their selection and successful use. They are classed as medium impact materials, but Izod impact test values shows their marked ability to absorb shock. This is due to extremely high flexural strength.

The melmac impact moulding compositions are supplied in the form of loose particles which have a bulk factor of from ten to fifteen to one. Black and an opaque mottled white are the two colours available at present. Several grades are offered, each with its own specific merits to meet particular needs. Details of their electrical and physical properties are included in the tabulated data. Brief notes upon the preparation and moulding, and finishing technique, of these materials is given below.

The melmac chopped fabric-filled moulding materials are packed in 30-lb. paper bags, which should be stored in a cool, dry place so as to ensure retaining the original moulding characteristics of the material. They are supplied in softer plasticities than other thermosetting plastics containing the same type of filler, and they mould with the minimum of resin segregation.

The melmac impact moulding powders are not readily preformed, although hand preforming similar to that practised on the other thermosetting impact compositions is satisfactory.

Large intricate mouldings are produced by the compression and by the transfer methods, dependent upon the design of the component. The resultant product retains its electrical or physical properties independent of its method of production. Vertically positive type moulds are recom-

mended in order to simplify finishing operations and to eliminate the exposure of fabric at the finishing line.

Moulds should be highly polished and preferably chromium-plated. High mould polish and good taper are essential because rather more pressure is required to eject mouldings of the impact quality than is necessary with melmac 1077 or mineral-filled melmac. To lubricate mould surfaces prior to initial loading, zinc stearate or carnauba wax is recommended.

The choice of transfer or compression methods depends upon the same factors already enumerated for the mineral-filled melmac moulding compositions.

Prewarming is strongly recommended because it promotes more perfect moulding. The closer the temperature of the moulding material to the temperature of the die before it is fed into the die, the better will be the resultant component physically and electrically. Prewarming may be achieved at temperatures from 160 degrees F. to 200 degrees F., with periods from 8 to 25 minutes, conditions being dependent upon the load of material to be heated and the method employed. When electrically or steam-heated stationary ovens are used the layers of compound on the trays must be thin, and the warm air must be kept in constant circulation. Preforms must be thin in order to secure the maximum of heat penetration. Infra lamp heating, of course, can be used, but the same comments apply. Rotary ovens have not proved very satisfactory because of the high bulk factor of the material. Electrostatic methods using high-frequency heating are useful.

Prewarming should not be avoided because it assists in rendering the moulding powder gas free, in minimizing resin segregation, and in producing finished mouldings free from strains and having maximum electrical characteristics.

Mould temperatures depend upon the size and thickness of the component to be produced, and may vary from 275 degrees to 350 degrees F. Large thick sections usually utilize the lower end of this range, and small thin sections use the upper end. The temperatures apply to compression and to transfer methods.

The pressures for transfer moulding vary from 10,000 to 30,000 lb. per sq. in. The lower pressures may be used for simpler parts and the higher pressures for large intricate components.

For compression moulding, pressures from 2,000 to 6,000 lb. per sq. in. are used, dependent upon the size and configuration of the component and upon its draw.

With regard to the moulding cycle, the melmac impact materials are best moulded by a simple straight closing of the mould. Bumping or breathing of the mould is not recommended. This is because of the nature of the filler, which makes it desirable to keep the compound moving uniformly, and slowly taking shape, thereby avoiding resin segregation or the tearing of the form. Strain lines and weakened sections are largely avoided if these recommendations are followed. The very high bulk factor of the moulding composition, and the nature of the filler, offer much resistance to the rapid closing of the die. During this relatively slow closure the escape of air and volatile matter is possible, and this generally makes breathing unnecessary. As with all the other melmac types, the impact grade remains plastic in the mould for a longer period than most thermosetting types and this permits of greater flexibility in the moulding operation and should prove of special value with the flock-filled grades.

Complete cure ensures that the optimum in physical and electrical properties is secured; overcure is evidenced by small hair-line cracks on the surface of the mouldings when they have cooled.

Table 5.—Cure Times for Compression Moulding 4-in. Dia. Discs, Melmac Impact Grade.

Cross Sections	Time—minutes
¼ in.	4
½ in.	6
½ in.	10

Table 6.—Table of Properties.

	Melmac 1,077 Alpha-cellulose filled (See Note 1 below)	Melmac P-3,020 Chopped-cotton filled (See Note 2 below)	Mineral filled Melmac		
			592 (See Note 3 below)	S-6,003 (See Note 4 below)	P-6,004 (See Note 5 below)
Electrical Characteristics					
Arc resistance—A.S.T.M.	125 secs.	111 secs.	133 secs.	175 secs.	186 secs.
Tracking resistance	Excellent	Good	Excellent	Fair	Excellent
Dielectric strength—A.S.T.M. Short time method (specimen .080 in.)					
Room temperature					
Specimen as moulded	340 V/M.	270 V/M.	535 V/M.	440 V/M.	470 V/M.
Specimen baked 40 hrs. at 220°F.	—	—	510 V/M.	450 V/M.	480 V/M.
At 100°C.					
Specimen as moulded	240 V/M.	—	490 V/M.	445 V/M.	415 V/M.
Specimen baked 40 hrs. at 220°F.	—	—	520 V/M.	490 V/M.	430 V/M.
Power factor—60 cycles A.S.T.M. method (specimen .080 in.)					
Specimen as moulded	3.7%	—	10%	11%	14%
Specimen baked 40 hrs. at 220°F.	—	—	4.5%	6%	9.9%
Power factor—10^6 cycles A.S.T.M. method (specimen .080 in.)					
Specimen as moulded	2.9%	4.1%	3.8%	2.8%	4.4%
Specimen baked 40 hrs. at 220°F.	—	—	3.0%	1.8%	3.5%
Dielectric constant—10^6 cycles A.S.T.M. method (specimen .080 in.)					
Specimen as moulded	7.0	7.2	5.65.	5.8	6.7
Specimen baked 40 hrs. at 220°F.	—	—	5.30	5.7	6.5
Physical Characteristics					
Specific gravity	1.49	1.4	1.7	1.98	1.98
Impact—Izod ft./lb.	.26	.686	.326	.308	.325
Flexural—A.S.T.M. lb./sq. in.	14,000	14,000	9,280	9,180	11,180
Deflection	62	49	27	21	25
Tensile strength—A.S.T.M.	7,570	7,000	5,900	5,920	6,620
Coefficient of Expansion +15°C.	44×10^{-6}	—	37×10^{-6}	22×10^{-6}	22×10^{-6}
Heat distortion	410°F	—	266°F.	266°F.	410°F.
H_2O absorption—A.S.T.M.	0.68%	1%	0.13%	0.07%	0.07%
Shrinkage—mould in./in.	.005in.–.007in.	.003in.–.004in.	.006 in.	.0057 in.	.0054 in.
After 8 hrs. at 220°F.	.004in.–.005in.	.002in.–.003in.	.001 in.	.002 in.	.0029 in.
After 48 hrs. at 220°F.	.010in.–.012in.	.005in.–.006in.	.0027in.	.0031 in.	.0044 in.
Heat resistance—¼ in. test piece	210°F.	220°–250°F.	300°F.	375–400°F.	300°F.
—up to ½ in.	210°F.	220°–250°F.	250°F.	300°F.+	—

1. *Melmac 1,077—General Characteristics.*
This material is superior to Beetle and other urea moulding compositions because it possesses better resistance to water, heat, food staining and abrasion. The moulding and preforming characteristics are equivalent to urea material.

2. *Melmac 3,020—General Characteristics.*
This material is a chopped-cotton impact material characterized by very high flexual strength. It possesses very good dielectric, arc resistance and flame resistance properties. The resistance of this product to water and food staining is excellent.

3. *Melmac 592—General Characteristics.*
This material is recommended for its general adaptability to most electrical insulation applications. It possesses good arc resistance, dielectric strength, heat resistance and moulding characteristics. Its physical properties are excellent and this material is readily mouldable around large inserts. It is satisfactory for either transfer or compression methods.

4. *Melmac S-6,003—General Characteristics.*
This product possesses the highest heat resistance of all the Melmac moulding compounds. It also possesses good arc, dielectric, and moulding characteristics. Its uniformity of arc resistance is not quite so good as Melmac P-592 and 6,004 materials. This material is not recommended for moulding around large inserts. It is satisfactory for either transfer or compression moulding.

5. *Melmac 6,004—General Characteristics.*
This material has excellent arc resistance, dielectric strength, heat resistance and moulding characteristics. It is a product possessing considerable brittleness and for this reason is not recommended for use on parts to be subjected to physical stresses or abuse. It is not recommended for moulding around large inserts. It is satisfactory for either compression or transfer moulding.

Table 5 gives a guide to curing times for the compression moulding of discs of 4-in. diameter, but in various thicknesses, the moulding temperature being 310 degrees F. For transfer moulding, the cycles are shorter, especially on heavier sections.

The test for cure previously detailed (10-minute boiling in a 1 per cent. solution of sulphuric acid) can be applied. Proper cure shows no surface attack or loss of gloss; poor cure reveals a satin-like or chalky finish under this test. Well-cured parts are resistant to boiling water and to most types of food staining.

For finishing, the melmac impact materials respond to the usual methods applied to other rag-filled thermosetting mouldings.

As an illustration of the uses of chopped melmac moulding compounds, moulded mess trays have been manufactured for the U.S. Army Medical Corps. These trays possess high flexural strength, low water absorption and good surface. Making use of high arc resistance, dielectric strength and flame and shock resistance, circuit breakers and telephone hand sets for heavy-duty service are also being made.

Table 6 represents data on many of the melmac melamine moulding materials in compact form. It is self-explanatory, except that some notes on the Rim Arc Test are necessary. It was developed by the Stamford Laboratories for the testing of plastic materials for arc resistance and to supplement the A.S.T.M. arc resistance test D495-42.

For the rim arc test, a moulded test piece is employed in the form of a flat-bottomed 4-in. diameter dish having ¼-in. rim around the edge. The intersection of the rim and the bottom is rounded to a 5-32-in. radius on the outside. The thickness of the moulding is about 0.075 in.

The testing apparatus comprises a turntable that can rotate at 2-3 r.p.m. and a pair of pointed electrodes which touch the sample, one above and one below the rounded juncture of the rim with the bottom of the sample. The electrodes are those normally used for the A.S.T.M. test and are tipped with a tungsten point similar to a lead pencil.

While the constants of the A.S.T.M. test are maintained as far as possible, a continuous arc is used, and therefore no time-interruption mechanism is required.

In carrying out the test, a sample is placed over the turntable, the electrode points are brought into contact with the rim, the turntable motor is started, and then the arc switch is thrown. Whenever the material breaks down and conducts, the arc switch is shut off for a few seconds until the carbonized path has moved by, and then again switched on to continue the test.

A set of conditions has been established as being an adequate measure of the quality of the moulding material, viz.:—

1. A maximum of 10 revolutions for each test.

2. The test is stopped when five breakdowns have occurred in one revolution.

3. The results are expressed as the number of breakdowns in each revolution, e.g.:—

(a) 0—0—0.
(b) 0—0—3.
(c) 0—2—5.
(d) 0—5.

It is claimed that, from the results of a large number of tests made by the two methods, it seems apparent that the rim arc test provides a measure of the frequency of occurrence of premature breakdowns or of areas of low arc resistance. The test will locate any areas of poor arc resistance due to a blending or combination of resins. The apparatus is shown in Figs. 3 and 4.

Further data upon the melmac moulding compositions is given in graphical form. Fig. 5 gives short time and step-by-step dielectric strength values for ⅛-in. mineral-filled material for temperatures from 60 to 400 degrees F. Fig. 6 gives the relationship between cure rates and mould temperature for alpha cellulose-filled melmac of 0.070-in. section. Fig. 7 shows similar data for

Fig. 3.—Arc resistance of "mixed" plastics is tested by the Rim Arc Tester.

Fig. 4.—Electrodes touch the rim of the plastic as it revolves on a turntable.

the chopped cotton fabric material in 0.125-in. thickness. Fig. 8 summarizes ageing shrinkage at 220 degrees F. for the various types of melmac, showing the marked superiority of the mineral-filled varieties in this respect. Finally, a schematic connecting line pressure, mould area, and ram size with mould pressure is given in Fig. 9.

Other Melamine Resins

Melamine resins under the patented trade names of melmac and melurac are also produced for thermosetting resinous bonding of various sheet materials such as cloth, asbestos, glass fabric, paper and purified wood cellulose. The laminations so produced are used for aircraft parts as well as for electrical, mechanical and decorative purposes.

The melmac laminating resins of the melamine formaldehyde class range from very hard to very flexible. The laminates are produced by high- and low-pressure techniques. The resultant sheets are characterized by exceptional qualities of

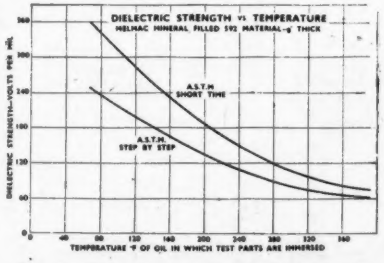

DIELECTRIC STRENGTH vs TEMPERATURE
MELMAC MINERAL FILLED 592 MATERIAL-¼ THICK
A.S.T.M. SHORT TIME
A.S.T.M. STEP BY STEP
DIELECTRIC STRENGTH-VOLTS PER MIL
TEMPERATURE °F OF OIL IN WHICH TEST PARTS ARE IMMERSED

Fig. 5.—Short-time and step-by-step dielectric strength values for ⅛-in. mineral filled material for temperatures from 60 to 400 degrees F.

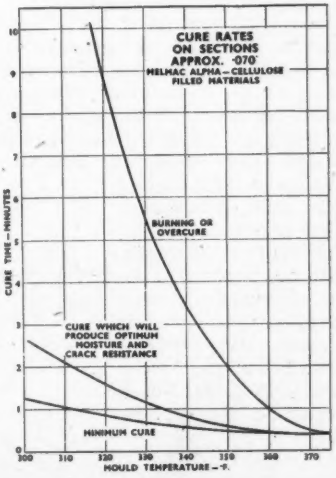

CURE RATES ON SECTIONS APPROX. .070 MELMAC ALPHA-CELLULOSE FILLED MATERIALS
BURNING OR OVERCURE
CURE WHICH WILL PRODUCE OPTIMUM MOISTURE AND CRACK RESISTANCE
MINIMUM CURE
CURE TIME-MINUTES
MOULD TEMPERATURE-°F.

Fig. 6.—Relationship between cure rates and mould temperature for alpha cellulose-filled melamine of 0.07-in. section.

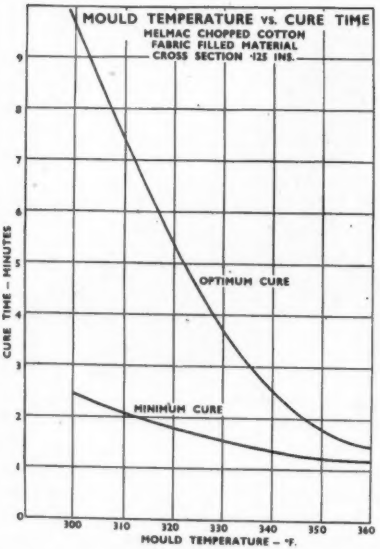

MOULD TEMPERATURE vs. CURE TIME
MELMAC CHOPPED COTTON FABRIC FILLED MATERIAL CROSS SECTION ·125 INS.
OPTIMUM CURE
MINIMUM CURE
CURE TIME – MINUTES
MOULD TEMPERATURE – °F.
300 310 320 330 340 350 360

Fig. 7.—Relationships between cure rates and mould temperature for fabric-filled material 0.125 ins. thick.

colour fastness, arc resistance, heat resistance and non-inflammability.

The melurac laminating resins include improved materials of melamine-urea base, and they create special interest for the production of laminated plastics at pressures as low as 30 lb./sq. in. It is stated that by using the bag moulding technique and inexpensive moulds, a multitude of laminates are easily fabricated for a variety of purposes.

Information appertaining to the merits of melamine formaldehyde resin adhesives are also given in "Bulletin des Scgweitz, Elektrotechnischen Vereins," Vol. 34, No. 2, January 27, 1943, pp. 50-52. They are among new adhesives introduced into the aircraft industry for joints in plywood components. They have also been used for making joints in pressboard, the joints having to be oil-resisting and electrically sound. These glues replace casein, dextrine and starch-water soluble products, which are used at ordinary temperatures and moderate pressures, and compete with the alcohol spirit solutions of phenol formaldehyde resins which are employed at higher pressures and temperatures of about 120 degrees C.

The original gives test values to indicate the mechanical and electrical strengths of joints made with various glues. The test pieces were made from a fine texture hard pressboard of specific gravity 1.35. They were cut in strip form and bevelled on a ribbon grinding machine. The test piece is shown in Fig. 10, which also shows its dimensions. The glues tested were as follows:—

1. Ordinary bone glue, liquefied by heating.
2. Acetylated cellulose in organic solvent, the surfaces being placed together immediately after application of the adhesive.
3. Melamine glue, a Swiss-made carbamide resin in aqueous solution, concentration 50 per cent. by weight.
4. Kaurit glue, a German-made urea-base aqueous adhesive.
5. Tego-glue-film, a thin paper

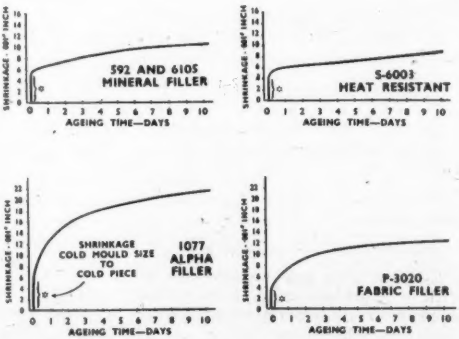


Fig. 8.—Ageing shrinkage at 220 deg. F. of various types of resin.

Table 7.—Strength Tests on Glues Using Pressboard Specimens.

Sample No.	Glue used for junction	Duration of pressure in minutes	Mean tensile load kgs.	Mean tensile strength kg./sq.cm.
1	Bone glue ..	6	140	390
2	Acetylated cellulose ..	10	142	395
3	Melamine glue ..	10	211	590
4	Kaurit glue ..	2	208	580
5	Tego glue film ..	6	125	350

Note: Tensile strength of the pressboard itself, 855 kg./sq. cm. in machine direction and 496 kg./sq. cm. in the cross direction.

coated on both sides with a special phenol-formaldehyde resin.

Immediately after the test pieces were coated, gluing was completed by pressing the specimens between two smooth brass plates at 100 to 110 degrees C. and 150 atmospheres pressure for from two to 10 minutes. They were then kept for at least 24 hours in air of 65 per cent. relative humidity. Next they were broken in a normal tensile testing machine. In every case failure was always at the junction, partly tearing the fibres off the opposite surface. Typical results are reproduced in Table 7, which shows the melamine and urea products very favourably.

In another mechanical test, a sheet of the pressboard was bevelled on two opposite edges, rolled into a cylinder of 110 mm. diameter, and stuck as before, except that gluing was achieved in a simple pressing device corresponding to the inner and outer diameter of the tube, pressing being for only one minute at 30 degrees C. Even the Tego-glue attained a tensile strength value of over 500 kg./sq. cm.

Table 8.—Electrical Strength Through Glued Joint in Pressboard, 5 mm. Thickness.

Sample No.	Glue used for junction	Electric strength, kilovolts	
		Test A	Test B
1	Kaurit glue ..	75	70
2	Melamine glue ..	76	69

The electric strength of the glued junctions of test strips as in Fig. 10 (except thickness 5 mm.) was tested after 24 hours' drying in an oven at 105 degrees C., and impregnating in transformer oil at 105 degrees C. for 72 hours. These tests were made under oil at room temperature. Voltage was gradually raised and maintained in 1 kilo-volt steps for one minute. The testing period is illustrated diagrammatically in Fig. 11. Results are shown in Table 2.

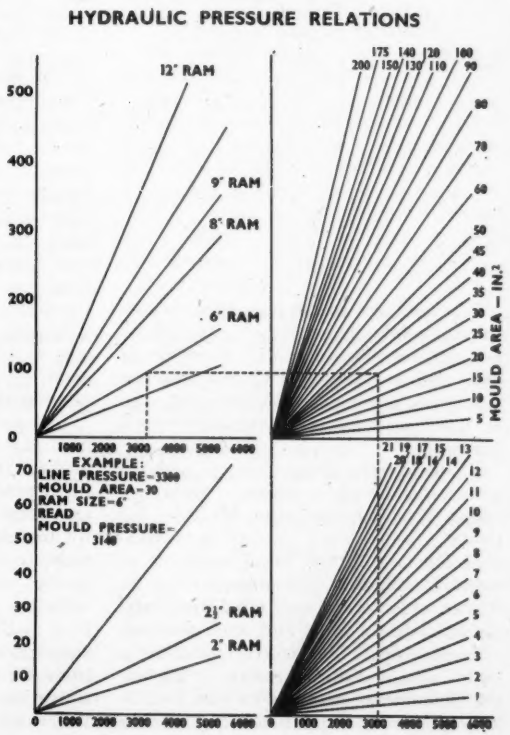


Fig. 9.—Hydraulic pressure relationship. A method of estimation of mould area from pressure and ram size, etc.

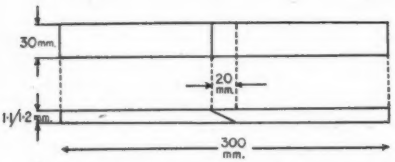
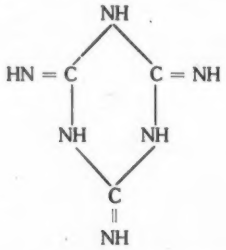


Fig. 10.—Pressboard test-piece for tensile strength tests on glued joints.

With tests on cylinders, using tin-foil electrodes, failure always occurred along the glued joints at voltages approximately two-thirds of those of pressboard of equal thickness.

H. W. Chatfield in his recent excellent book, "Varnish Constituents" (Leonard Hill, Ltd., London, 1944), gives a concise summary of the properties and uses of the melamine resins. Melamine itself is 1.3.5 triamino 2.4.6 triazine, and it has the following structural formula:—



It is the three amino groups that render this material highly reactive, and which permits of condensation with aldehydes to yield resinous products. Other reactive modifying agents may be included, and it is clear that the potentialities are numerous.

Chatfield states that, compared with the urea-formaldehyde resins, melamine resins show improved compatibility. He quotes beetle resin 52 as a typical melamine resin, this being available in butanol solution. The solution may be diluted extensively with ethyl and butyl alcohols, ethyl, butyl and amyl acetates, acetone, glycol ethyl ether, aromatic hydrocarbons and turpentine. Substantial amounts of white spirit can also be added before precipitation occurs. With

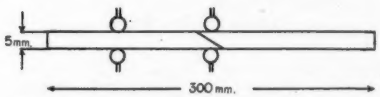


Fig. 11.—Pressboard test-piece for electric breakdown between spherical electrodes.

respect to plasticizers, it is interesting to note that alkyds have been specially developed for this purpose, and that those modified with non-drying and with drying oils can be suitable. Compatibility with the usual range of plasticizers is good, and better than with the urea resins. It is also excellent with cellulose nitrate.

The thermosetting temperature is relatively low, and 180 degrees to 220 degrees F. is satisfactory with periods from half to one hour. At the higher temperature of 250 degrees F. from 10 to 20 minutes is sufficient. In contrast, the urea formaldehydes require from half to one hour at 250 degrees F. These low temperatures and rapid curing characteristics are attractive features.

Another advantage of the melamine resins is heat stability, with resistance to degradation. Even at 400 degrees F., colour, gloss and adhesion are retained by certain combinations of melamine and alkyd plasticizer. Resistance to light is good, in which the material equals the urea resins, but the latter are inferior in resistance to heat. Again, comparing with the ureas, the melamines possess superior resistance to water, to acids and alkalies, and to solvents. Further, they exhibit good electrical insulation and excellent non-tracking properties.

In consequence of these properties the melamines are used in organic finishing media. In this field, stoving enamels for rapid processing without yellowing are an important item, particularly light colours for refrigerator finishing. Oil and petrol resistance renders the melamine base media suitable for the finishing of vehicles, garage equipment, etc., while heat resistance makes them suitable for purposes such as ovens, radiators, electric irons, etc. Electrical qualities claim consideration of the material for coil insulation, and especially for insulator and

panel finishes where non-track properties are sought.

Summarizing, it is seen that as a plastic the melamines offer rapid curing, and give products having unique properties of non-stain and abrasion resistance, hardness, shock resistance and electrical non-tracking qualities. The usual range of types can be obtained and variety of products formed. Correct technique in handling needs to be acquired, but no undue difficulties are anticipated. The finishing and adhesive fields are served. Undoubtedly, these products will be sought with eagerness as soon as available in this country, and subjected to tests with respect to service conditions encountered in comparison with the more known plastics. At the same time it is stressed that a greater field exists for the melamine materials for components and equipments for which existing materials were not entirely satisfactory, and, therefore, were not employed, rather than in the displacement of known plastics from existing applications.

LETTERS TO THE EDITOR

Transparent Flexible Tubing

We shall be glad if you can assist us by giving us, if possible, the names and addresses of the manufacturers of transparent flexible plastic tubing.

D.H. (ENGINEERS), LTD.

Ipswich Road,
Trading Estate, Slough.

Durez Resin

Contained in your edition of "Plastics" dated January, 1943, there was a short mention concerning the application of Durez resin as a binder for mineral wool for the manufacture of an insulating blanket.

I would be pleased if you could give me any further information regarding these resins or let me know the address of the Durez Plastics Co., of New York State, who are the manufacturers of this resin.

GYPROC PRODUCTS, LTD.

Rochester. (Research Dept.).

[EDITOR'S NOTE: The address of Durez Plastics and Chemicals Inc. is N. Tonawanda, N.Y. The resins are, we understand, of the phenol-formaldehyde type.]

Research on Magnets

We are interested in the article entitled "Plastic-bonded Magnets" which appeared in the March issue of your journal "Plastics," and should be pleased to know whether anyone is carrying out research on this subject in this country.

THE RHEOSTATIC CO., LTD.
(Engineering Department).

Slough, Bucks.

Imports Into South Africa

We are organizing a local industry of synthetic materials and we wish to co-operate with British manufacturers-producers of synthetic resins for plastics, either as a branch factory or as exclusive importers of the raw resins for further processing in South Africa, and the production of low-cost competitive materials for present and post-war business development. INDUSTRIAL GLOVES.

Johannesburg.

Plastic Finger Guard

The notice in your journal had the desired effect. Several firms have written to us stating their willingness to undertake the manufacture of this guard.

We very much appreciate your co-operation in this matter.

Royal Society for the Prevention of Accidents,
(Manager, Industrial Dept.)

Pollopas

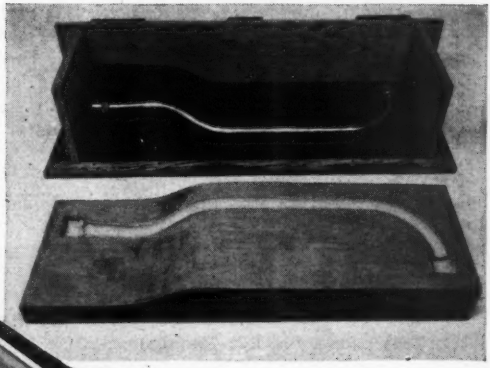
Our representative in Belgium is proposing to import as soon as possible large and regular supplies of a plastic powder known as "Pollopas." Can you give a source of supply?

HOLT, WHITNEY AND CO., LTD.

Birmingham, 4.

More Plastic Tools and Jigs

We have great pleasure in publishing the letter below and the accompanying photographs we have received from Pobjoy Airmotors and Aircraft, Ltd.



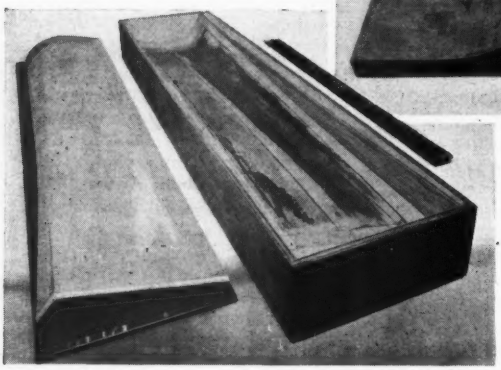


Fig. 1 (above).—Pipe-bending reference gauge in the foreground moulded from an actual pipe supported in Kamite plastic stone shown in the rear. Materials: Catalin thermo-setting resin, Kamite cold-setting plastic stone supplied by F. and M. Suppliers.

Fig. 2 (left).—Large rubber press tool moulded accurately to size from existing checking template, built up to form the mould as illustrated. Material: Catalin thermo-setting resin.

IN view of the interest which is at present being displayed on the cast resin tooling process through the medium of your journal, we consider it would be appropriate to draw attention to the development work which Messrs. Pobjoy Airmotors and Aircraft, Ltd., are carrying out in this direction. We have carefully studied with great interest your recently published articles on this subject, chiefly concerning American methods, also the interesting letter and photographs from Mr. H. C. Martin, of the Bristol Aircraft Company, which you published in your last issue.

We heartily agree with Mr. Martin that it is a great pity that more attention should not be paid to British efforts in this new field of jig and tool manufacture. We should, however, like to correct the impression that your readers might well obtain from Mr. Martin's letter that, apart from the excellent work carried out by the Bristol Aircraft Company, little or no development work on cast resin tooling is being carried out elsewhere in this country. Messrs. Pobjoy Airmotors and Aircraft, Ltd., have also been undertaking a programme of development on cast resin work to simplify the method of tool manufacture, and we feel sure that your readers will be interested in the enclosed photographs of some of the types of tools we have produced, as we consider that our developments in this new field of jig and tool manufacture are well advanced.

J. R. Cross,
Technical Supervisor (Plastics).
(Pobjoy Airmotors and Aircraft, Ltd.)

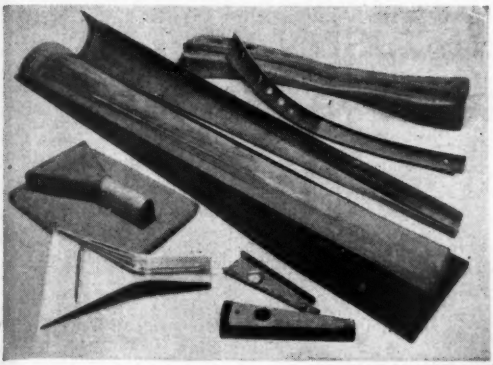


Fig. 3 (left).—Group of miscellaneous rubber press form tools for aircraft details ready for immediate use after casting. (Material : Catalin thermo-setting resin.)

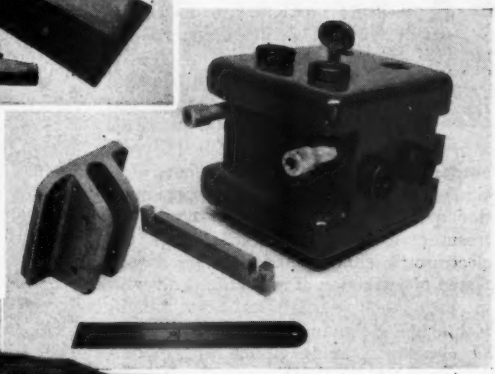


Fig. 4 (right).—Drill jig body moulded in one operation from an actual metal detail built up to form the pattern. All steel bushes, clamps, screws, etc., set in cerromatrix, at a low melting point. (Material: Catalin thermosetting resin.)

Fig. 5 (left).—Illustrating a method of producing a rubber press former, using an actual part as a master, supported by Kamite plastic stone. built up to give the required thickness. The actual tool as cast, together with detail part produced on it, is shown on the right. (Materials: Catalin thermosetting resin; Kamite cold-setting plastic stone supplied by F. and M. Suppliers.)

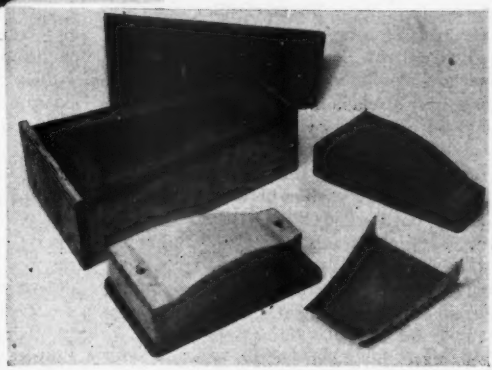


Fig. 6 (right). — Simple method of moulding rubber press formers, templates, etc., made from a wooden pattern, our impression being made in Kamite plastic stone and a resin poured directly into the mould. The actual tooling holes set in cerromatrix on a base plate together with an actual part produced from it is shown in the foreground. (Materials: Catalin thermo-setting resin ; Kamite cold-setting plastic stone supplied by F. and M. Suppliers.)

World's Industry Employs Plastics

GENERAL ENGINEERING

Electrostatic properties of rubber and G.R.S. are dealt with by Havenhill, O'Brien and Rankin in the "Journal of Applied Physics" for November, 1944. (This issue, incidentally, is entirely devoted to high-polymer physics.) The authors of the paper mentioned have developed a new-type electrostatic modulator for measuring the electrostatic charges under consideration. **Speed of retraction of rubber** is dealt with in the same journal by Stambrough, Rohne and Geliman. The authors employ an electronic timing circuit with photocell input. With this apparatus, measurements were taken with Hevea and synthetic rubbers as a function of elongation, temperature, carbon-black loading and cure. **Stress-temperature relations at constant elongation and at constant length** have been studied in a pure gum vulcanizate G.R.S. by Roth and Wood. The same authors report of stress temperature relations in a pure gum vulcanizate of natural rubber. **Effect of filler upon the modulus of compounded rubber** has been calculated by Smallwood on the basis of certain simplified assumptions. Young's modulus of elastomer at low temperatures has been studied by Conant and Liska on a modified form of the customary apparatus. **Structure of rubber fibres and the distribution of carbon-black** in the fibres has been studied by Hall, Hauser, Le Beau, Schmidt and Talalay ("Industrial and Engineering Chemistry," 1944/36/634). The authors use the electron microscope with magnifications ranging from 19,000 to 94,000 diameters. Materials examined included Hevea, guayule and cryptostegia, Buna S and neoprene. **Wear phenomena of gear drives composed of steel wheels running with laminated plastic wheels** were investigated by Gimbel ("Metallwirtschaft," 1944/22/375). Steel wheels in material according to Din.St.C.60.61 running at 3,000 and 1,500 r.p.m. suffered destruction of flanks after 40 million revolutions, the laminated mating wheel remaining undamaged although it was observed that the tooth flanks of the latter contained numerous fine steel chips embodied in their surface. The abrasion-resisting capacity of the laminated plastics used for gears appears to be inversely proportional to the fineness of the textile filler used and the hardness of the matrix. **Flow sheet of plywood manufacture** has been prepared by Zeelander, who describes the general production procedure and presents some data on the glueing processes used. ("Mechanical World," 1945/117/211.) **Belting, hose, packing, linings, abrasive wheels,** etc., used in the metal-working industries employ five different types of synthetic rubbers. Data on the selection, physical characteristics and types best suited for each purpose are presented by Such in "Steel," 1944/115/112. **Solid flat-sawn non-resinous wood and veneer,** spread with glue and assembled in parallel laminated or cross-banded form, can be compressed to a high specific gravity product. It does not tend to spring back under moisture-absorbing conditions when so compressed that flow of the lignin in the mass takes place. This theory is utilized in manufacture of a product called Staypak, the principal physical properties of which have been determined by Seborg Millett and Stamm. ("Mechanical Engineering," 1945/67/25.) The impact strength of Staypak is higher than that of Compreg, but its

dimensional stability is not so high. Due to high loss of valuable steel equipment and components because of rust and damage in transit during overseas shipments, technical resources in U.S.A. were mobilized to develop **economic transit materials.** About 47 concerns share in the production of nine specific preservatives, usually of a plastic-base type applied by hot dipping. This subject is surveyed by Knight in " Metals and Alloys," 1944/20/934. **Various types of adhesive for producing compound masses of wood and metal,** wood and plastic, etc., are surveyed by Rose in " Metals and Alloys," 1944/20/959. Amongst the materials and processes discussed are Cycleweld, Cyclebond, Rearnite bonding, Metlbond and Durite cement. Attention might at this point be directed to the Redux process widely used in this country and to another system of metal-to-non-metal bonding evolved by High Duty Alloys, Slough. **Toolite and Plastalloy,** trade names for a new thermo-setting and a new thermo-plastic material respectively, designed for tool manufacture. ("Tool Engineer," 1944/Dec./p.101)

SHIPBUILDING

New type laminated timber product capable of giving satisfactory glue-joint performance under extreme conditions of exposure has been developed on behalf of the Navy Bureau of Ships and the Office of Production Research and Development of the U.S. War Production Board. Such laminated timber, it is said, may be expected to be as resistant to decay, insects and fire as solid timbers of the same kind of wood. The technique investigated employs low-temperature phenol, melamine, and resorcinol-resin adhesives and has been used successfully in the fabrication of more than a million cubic feet of white-oak ship timbers. (" Mechanical Engineering," 1944/66/73.) **Laminated timbers of large size and irregular shape** can now be produced by means of phenolic adhesives setting at 200 degrees F. The shear strength of the wood is maintained at practically 100 per cent.

CHEMICAL

Lightweight laboratory and industrial aprons of high-grade cotton fabric coated with vinyl resin are claimed to be proof against water, oil, grease, acids and alkalis, and are thus well suited for laboratories, battery rooms and plating shops. (" Automotive and Aviation Industries," 1944/91/96.)

AIRCRAFT

Three-piece bakelite housing of motor gear for retractable landing lights is embodied in certain of the newest types of military aircraft. Two of the sections contain moulded-in metal inserts. (" Automotive and Aviation Industries," 1944/91/90.)

MOTORS

Relationship between tyre and tyre pressure has been investigated by Zoeppritz, with particular attention to tyres made of synthetic rubbers. The author, instead of employing the conventional drum-type testing machine, used a plain surface-testing equipment, in which was embodied pressure control and change device controlled from the switchboard of the experimental set-up. (" Automobil Techn. Z., 1942/45/353.)

ELECTRICAL

Sound recorder in which acetate-coated wire is sensitized by an electro-magnetic field has been developed by the Armour Research Foundation and is now being manufactured by G.E.C. (" Popular Science Monthly," 1944/Dec./p. 201.) **Non-metallic fixtures for induction heating apparatus** are made of Transite, a plastic-bonded asbestos board. Joints are made by screw bolts in tapped holes or screw bolts with nuts and small angular plates of non-magnetic materials, such as aluminium or brass. A complete range of such fixtures is shown in perspective drawings. (" The Machinist," 1945/88/101.)

MISCELLANEOUS

Further development in the use of **transparent models** are referred to in " Machine Design," 1944/16/79. The account refers particularly to apparatus designed to study the flow of lubricant through a bearing. As is customary, the oil supplied by the circulating pump in the system is tinted so that the operation of the set-up can be studied. **New type flash camera in plastics** embodies numerous unorthodox moulded-in constructions; details of the apparatus are described by Barret in a well-illustrated account in " Machine Design," 1944/16/85. **Directory of materials,** including some 300 plastics classified under their trade names, is given in the same issue of " Machine Design." The following properties are tabulated: corrosion resistance; heat resistance; impact strength; tensile strength; dielectric strength. Details of polish, optical properties, capacity for taking colour and reactions to moisture are also presented. An index enables cross reference to be made to principal trade names of groups of plastics. A list of producers of plastics and other non-metallic materials includes 130 names and addresses, whilst moulders are credited with 166 entries, the type of plastic and nature of mouldings produced being specified. Most appropriate conditions for **storage of lac** have recently been investigated by the Indian Lac Research Institute, and a brochure issued by the London Shellac Research Bureau deals with the problem of reconditioning blitzed lacs or those which have been kept long in storage. (Shellac Research Bureau Technical Paper, No. 5.) **Cellulose and cellulose derivatives** form the subject of a recent publication by Inter Science Publishers Inc., New York. The volume is edited by Emil Ott. Novel type **storage tanks for drinking water** have been produced for use in the Pacific war zone. They are made of glass fabric coated with synthetic rubber and are collapsible, being easily folded up for transport. The tanks are 54 ins. high, 11 ft. in diameter, and hold 5,000 gallons. (Bull. Am. Ceram. Soc., 1944/23/492.) **New rubber laboratory and factory** installed in the Amazon Valley by Bekkadhl and Rubber Section of the National Bureau of Standards is subject of Technical News Bulletin, Dec., 1944, p. 89. A wide variety of trees other than the common Hevea Brasiliensis are under investigation. **Mass spectrometer** is being employed by Brewer of the National Bureau of Standards for the investigation of liquid and gaseous materials employed in the production of butadiene and styrene. (" Technical News Bulletin," 1944/Dec./p. 90.) New **technical commission for the standardization of plastics** has been created by the Swiss Standards Association. Recommendations for the testing of plastics issued some time ago by the Swiss Association for Testing Materials have also been revised. In regard to thermosetting resins such tests include tensile tests, compression tests, bend tests, shear tests and impact bend.

Preformed Plastics

OUR short note regarding recent American work on this subject, mentioned in the "World's Industries Employs Plastics" section of this journal in our March issue, has resulted in several inquiries for more information. We have, therefore, abstracted further details and have reproduced herewith a few of the photographs from the original article in the July 20 issue, 1944, of "The Iron Age."

The preformed plastic described is the result of five years' research by the chemists of the Westinghouse research laboratories and the Mellon Institute of Industrial Research in Pittsburg. The resulting materials which can be prepared with a wide range of characteristics are described as generally possessing one-third the strength, and one-third the weight of aluminium (presumably in the pressed form as distinct from extremely light shapes which are also made). The widest use to date is in the construction of aircraft parts where non-buckling properties are designed.

Manufacture resembles basically that already described in this journal for British preformed plastics, namely, it follows the art of papermaking—the production of a dispersion of fibres in water and the "filtering" out of the fibres on a metal screen.

The initial liquid consists of a thick soup-like mixture of cellulose fibres, 99 per cent. water and a phenolic resin, the

Fig. 1.—The copper screen being hoisted out of the tank after the pump has sucked the fibre-resin mixture from the watery suspension.

Fig. 2.—The press (here fitted with a wooden tool) compresses the preform into the finished shape. Low presses can be employed.

Fig. 3.—The completed preformed object—an aircraft tail fillet.

latter being a special type insoluble in water but with affinity for the pulp fibres. Doubtless the maintenance of definite controlled acidity of the mixture is essential.

In the preforming process, a fine copper gauze fashioned into the form of the finished product is fitted to the end of a suction pipe and then dipped into the mixture. A vacuum pump sucks the mixture to the gauze form, which permits the water to pass through the tiny holes, leaving the damp, resin-soaked fibres clinging to the screen in a uniform layer. Then the preformed piece is peeled off the gauze form and dried in a warm oven.

The dried piece is then placed in a heated mould and pressed into its final shape. Under this treatment, the resin melts and flows through and around each tiny fibre. By varying the time or the amount of suction during preforming, the thickness of the preformed piece can be varied, and the amount of pressure can be changed to make different varieties of plastic, ranging from a cork-like substance to a dense, strong material resembling hardwood. Inexpensive dies made of wood can be used in the press.

Physical Properties of Plastics.

Type	Tensile strength, lb./sq. in.	Flexural strength, lb./sq. in.	Impact strength, in./lb.
Preformed	14,000	18,500	65
Laminate	14,000	20,000	54
Moulded	7,600	10,000	36

The accompanying table compares the strength of a preformed plastic made from craft pulp fibre and a simple phenolic resin.

Flame Resistance of Plastics

According to Gale, Stewart and Alfers (A.S.T.N. Technical Bulletin No. 131, December, 1944), a flame-resistant material is defined as one possessing the following characteristics:—(1) High ignition temperature; (2) low burning time; (3) absence of smouldering after the flame is extinguished; (4) retention of strength after burning. The method of test is an adaptation of test method LP-406a for determining flame resistance of shipboard cables. A nichrome heating wire coil is used as heating element with specimens supported within the coil. Tests were conducted upon 16 moulded and 10 laminated thermosetting plastics. Most moulded phenolics had ignition temperatures in the vicinity of 400 degrees C., while several filled types went up to above 600 degrees C. Melamine types possessed higher ignition temperatures than phenolics.

Resin-treated Plaster of Paris

By H. Courtney Bryson

ALTHOUGH hundreds of thousands of tons of plaster of paris are produced annually, and used for a huge variety of objects varying from wallboard to plaster saints, the unique properties of this material have not by any means been fully exploited. In the widest sense of the word, plaster of paris is the most plastic of substances, in that it is capable of being shaped with comparative ease into a wider variety of forms than any other readily available cheap material. Large or small, complicated or simple, with re-entrant angles or smooth, all shapes are made with almost equal facility from plaster of paris. A shirt button or a gasholder are merely problems in size as far as fabrication from plaster is concerned. On the permanence of plaster of paris it is not necessary to enlarge. The buildings of the White City Exhibition, at Shepherd's Bush, London, were constructed some 40 years ago from plaster of paris hardened with alum, and were still in fair condition at the time of the London blitz. Before making some observations on the methods of overcoming the two chief defects of plaster of paris—water absorption and lack of strength—it will be as well to give a few notes on the usual method of manufacture adopted for the production of repetition plaster articles, such as the statues and ornaments sold in pre-war days chiefly by Italians. The basic cost of the average statuette was of the order of a few pence since raw material is cheap and production rate high. The moulds are made from gelatine, which is cast round the master model and then cut up into two or more parts. The mould sections are laid side by side down the length of a long table. The plaster is gauged (with water) by the skilled workman, who takes the slurry and pours it into the first mould, assembles the pieces together, and, holding the complete mould firmly in both hands, makes a rotary motion with his arms about a horizontal axis so that the plaster slurry is distributed by centrifugal force round the interior of the mould. He then passes on to the second mould. By the time the man has reached the end of the table the first mould is ready for extraction. During setting, plaster of paris expands slightly, thus ensuring an accurate reproduction of the mould surface. The pieces of the mould are dissembled by a boy assistant, the article extracted and the mould brushed out ready for refilling by the workman, who, by this time, has finished his tableful and has gauged another lot of plaster. The man and the boy thus follow each other round. When a mould becomes worn—and they do not last very long—it is simply remelted and recast. Air bells and other defects in the plaster are filled in with a little fresh slurry and the rough parts trimmed up with a small knife. The ease and simplicity of the process are immediately apparent.

Drawbacks Can be Overcome

It is probably solely the defects of lack of strength and lack of water resistance that have prevented plaster of paris being used commercially for the manufacture of technical articles. Now these two drawbacks may be largely overcome simultaneously by impregnating the plaster with a synthetic resin. Though almost any resin having good strength and water resistance could probably be employed, a liquid phenolic resin syrup was selected as being the most satisfactory by heating the following constituents together till the water had evaporated and a syrup remained, tested by spotting on a glass plate.

Phenol	=100
40 per cent. formaldehyde	=100
Ammonia	=8

Cast plaster articles were immersed in this solvent-free synthetic phenolic resin syrup maintained at a temperature of 70 degrees C. to reduce viscosity and induce good penetration, which was further augmented by maintaining a vacuum over the surface. When bubbles ceased to rise from the articles being treated (a period varying with the thickness of the article), the specimens were extracted, allowed to drain and then cured in an oven, some suspended by cotton and some on sticks. Curing was carried out very slowly to avoid bubbling.

Curing of the Resin

During the curing process a film of resin rises to the surface which finally becomes entirely covered to a depth of several thousandths of an inch, with a clear, glossy and quite attractive layer of resin. A simple weighing indicates that the plaster absorbs some 45-50 per cent. of its weight of resin. The strength, as would be expected, is also greatly increased.

It is obvious that, for commercial use, the gelatine moulds would be replaced by rubber moulds, and this can be done quite easily. It will be found that a little lubricant on the surface of the rubber is a great advantage. Although it would mean that an oil-resistant grade of rubber is required, in actual practice any standard soft rubber mix, especially if it incorporates a fairly large amount of wax, will be found entirely satisfactory. The life of rubber moulds is excellent.

The gauging of the plaster can be easily performed. A cistern delivering a specified volume of water is arranged overhead and a series of roses are arranged over a simple mixer. The flushing of the cistern liberates a given volume of water on to a weighed amount of plaster in the container, and the resulting slurry is immediately used for casting. If an even simpler method is desired, then a rubber cup, such as dental mechanics use, is filled to within one inch of the top with water and plaster is shaken in till the level of the plaster just comes up to the top of the water. When this occurs, the proportions are exactly right to make a good pouring slurry. A rubber container is selected as it is so easy to remove set plaster from the surface. As an example of how useful the technique outlined above may prove to plastic moulders, a short time ago an inquiry was received for six dozen black teapot handles, price being unimportant but a speedy delivery was essential. These were cast by the process given above, dyeing the impregnating resin black. The customer was pleased both with the result and the quick delivery.

In conclusion, it would appear as if a considerable outlet exists for impregnated plaster of paris as an adjunct to normal plastic moulding, especially where intricate shapes or small quantities are involved.

Anglo-American Industrial News-letter

We have just received a copy of the Anglo-American Industrial News-letter, and its publisher has extended an invitation to British manufacturers to send short announcements of new products to the Editorial Office at 8, West 40th Street, New York, 18, N.Y., for inclusion, without charge, in the American, Australian and Swedish editions.

The News-letter carries advertising, but this is limited to firms desiring to establish agency representation or to obtain a licence to manufacture products which are at present made overseas.

The Anglo-American Industrial News-letter is a 10-page résumé of American industrial developments, and is issued monthly at an annual subscription of 40s., payable to the British office at Digswell, Welwyn Garden City, Herts. The News-letter lists new products and processes developed in the U.S.A., includes a lengthy list each month of bulletins, offered without charge by American manufacturers, that are noteworthy contributions to the literature of the particular industry to which they are addressed, and the News-letter lists the titles of more significant articles appearing in the American trade and technical Press, as well as important U.S. patents with a brief description of those selected.

Income Tax and Expenditure on Scientific Research

By JOHN LYMESTER

DURING the course of his Budget speech the Chancellor emphasized the necessity of an increased export trade in the post-war period. He outlined certain proposals as to taxation in this period, including the treatment of expenditure on scientific research. He mentioned that research had three aspects. That is:—

1. The fundamental research of the scientist in the universities, or in the laboratories attached to industrial establishments, or organizations.

2. The next stage when the results obtained in the first stage are tried out on a large scale.

3. The final stage when commercial production is tried.

The Chancellor's proposals as to scientific research were contained in the Finance Bill and they are now law as Sections 27 to 31 of the Finance Act, 1944.

None of the provisions contained in these sections will come into force until the appointed day—that is, a date to be fixed by Parliament, which as we know means a date as soon as possible after the end of hostilities, when there is a return to peace-time production.

Definitions of Scientific Research

"Scientific research" means any activities in the fields of natural or applied science for the extension of knowledge, and "scientific research expenditure" means expenditure incurred on such activities, but this does not include any expenditure incurred in the acquisition of rights in, or arising out of, scientific research, but it does include all expenditure for the prosecution, or facilities for the provision, of scientific research. When in the provisions as to scientific research references are made to scientific research as related to a trade or class of trades, this includes any scientific research which may lead to, or facilitate, an extension of the trade or trades and any scientific research of a medical nature which has special relation to the welfare of the workers.

Throughout these provisions "the appropriate Research Council or Committee" means the Committee of the Privy Council for Scientific and Industrial Research, the Medical Research Council established under the Committee of the Privy Council for Medical Research or the Agricultural Research Council established under the Committee of the Privy Council for Agriculture Research, according as may be appropriate in relation to the activities in question.

By Section 27 of the Finance Act, 1944, where a trader after the appointed day:—

(a) Incurs expenditure for scientific research not of a capital nature and the research is directly related to his trade and is undertaken by him or on his behalf;

(b) pays any moneys to a scientific research association which has been approved by the appropriate Research Council or Committee and which undertakes research related to the class of trade to which the trader belongs;

(c) pays any moneys to a university, college, research institute or similar institution which is approved by the appropriate Research Council or Committee for the purposes of scientific research in a class of trade to which the trader belongs;

shall be an allowable expense for the purposes of computing profits for income tax.

By Section 28, where, after the appointed day, a trader:—

(a) While trading incurs capital expenditure for the purposes of scientific research undertaken by him or on his behalf;

(b) incurs capital expenditure for the purposes of scientific research undertaken by him or on his behalf and then sets up a trade as a result of that research;

the expenditure can be written off against the assessments for five years, as follow:—

1. If incurred before the end of the year of assessment in which the trade was started then that and the four succeeding years.

Thus, assuming the date appointed by Parliament is April 6, 1947, and the business is started on June 1, 1947, and the expenditure incurred before April 6, 1948, the deduction can be made from the assessments for 1947/48, 1948/49, 1949/50, 1950/51 and 1951/52.

2. If incurred after the end of the year of assessment in which the trade was set up, but not more than 12 months from the starting of the business, then the assessments shall be those following the month in which the trade was set up and the next four.

Assuming the date appointed is April 6, 1947, and the business is started on June 1, 1947, and the expenditure is incurred in May, 1948, the deductions will be made from the assessment for 1948/49, 1949/50, 1950/51, 1951/52 and 1952/53.

3. If incurred more than 12 months from the starting of the trade and during the basis year for any year of assessment the five years shall be that year of assessment and the next four.

Thus, assuming the date appointed is April 6, 1947, and the business started on June 1, 1947, and the expenditure is incurred in the financial year ending December 31, 1950, that is the basis year for the year of assessment 1951/52, the five years 1951/52 to 1955/56.

This is subject to:—

(a) Where two basis years overlap, any expenditure in the period common to both shall be deemed to have been incurred in the first basis year only; and

(b) where there is an interval between the end of the basis year for one year of assessment and the beginning of the basis year for the next year of assessment, any expenditure incurred during the interval shall be deemed to have been incurred in the second basis year;

(c) any expenditure which is incurred before the end of the business but after the end of the basis year for the last complete year of assessment before the permanent discontinuance of the trade, shall be deemed to have been incurred in the basis year mentioned.

The basis year means the preceding year which is to be taken as the profits of the year of assessment.

By Section 29 there are certain qualifications of the provisions of Section 28 when an asset of a capital nature ceases to be used for the purposes of scientific research. These are as follow:—

(a) There shall be no deduction for any year of assessment after that in which the asset ceases to be used.

Thus, if an asset for which the one-fifth deduction can be claimed ceases to be used on December 31, 1950, no deduction can be claimed for 1951/52.

(b) If the deductions allowed plus the value just prior to the cessation of use of the asset are less than the total expenditure on the asset, the difference will be allowed in the year of assessment in which the cessation takes place.

Thus, if the expenditure is £1,000 and £200 is allowed in 1951/52 and 1952/53 and the asset ceases to be of use in 1953/54 and its value is then only £100, then £500 is allowed in 1953/54—that is:—

£200	1951/52	(one-fifth allowance).
£200	1952/53	(one-fifth allowance).
£200	1953/54	(one-fifth allowance).
£300	1953/54	difference in expenditure, amounts allowed and residual value.
£100		residual value.
£1,000		

(c) The asset if used for other purposes in the trade may be admissible for wear and tear, obsolescence and exceptional depreciation. The amount on which these claims shall be calculated is the cost less the amounts allowed under Sections 28 and 29 as explained above, but this is the only circumstance in which wear and tear, etc., can be claimed on assets which are the subject of a scientific research claim.

Where an asset is valued because it ceases to be used for scientific research and thereafter is sold and:—

(a) The sale price is less than the amount at which it was valued, then an additional allowance will be granted in the year of sale or alternatively if the business has discontinued in the last year of assessment.

(b) The sale price is more than the amount at which it was valued, then the excess shall be treated as a trading receipt in the year of sale, provided always that this figure does not exceed the allowances granted; if it does the allowances previously granted are taken as the amount to be assessed.

Should an asset be destroyed by fire, etc., the compensation received shall be treated as the sale price.

These allowances can be carried forward in the same manner as wear-and-tear allowances and, similarly, if losses cannot be claimed because of the prior allowances of these claims, the losses can be carried forward indefinitely until used. Finally, throughout, references to an asset include a part of an asset.

When these reliefs are in force they should considerably assist industry, especially as regards improved methods of production, new processes and staff welfare.

A Testing Machine for Plastic Bearings

The Equipment Described Attempts to Simulate Practical Operating Conditions. (After an Account in "Kunststoffe," 1943/33/270 and 1944/34/79.)

By
H. CONRADT

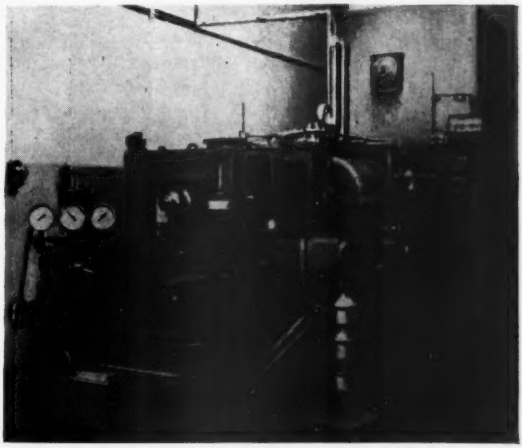


Fig. 1.—General view of the testing machine for plastic bearings, as designed by Conradt. The speed control can be seen at the rear, whilst, in the foreground, may be seen the plummer blocks for the supporting bearings of the test shaft.

THE problem confronting the author of this account was to develop testing equipment for investigating the running properties of standard bearings as used in machines. Owing to the swelling effect on plastics caused by water- or emulsion-lubricated bearings, it was necessary so to design the plant as to be able to measure daily the bearing clearance. Furthermore, it was desirable to record friction phenomena by a friction balance, and to measure the temperature of the lubricating film at regular intervals. Load and speed had also to be recorded, as well as the supply of the lubricant and its temperature, at inlet and outlet. It was also intended to determine the distribution of pressure in the lubricating film, but this could not be realized owing to difficulty in fixing measuring points in the flexible plastic material. For observing changes in the position of the balance beam of the friction balance, it was necessary to use built-in measuring instruments. Finally, suitable devices had to be provided for the control of speed, bearing load, temperature, and oil supply to the bearing.

General Design

The size of the machine was determined by the shaft diameter of the bearing to be tested and the maximum bearing pressures decided upon. The standard shaft had a diameter of $4\frac{3}{32}$ in., the bearing load being controllable from zero to 94,000 lb. With a ratio of bearing length to diameter of $l/d = 1$, the projected area of the bearing was about 19.2 sq. in. and the highest specific bearing pressure was 5,000 lb./sq. in. The machine was driven by a three-phase slip-ring motor, driving through vee-belts to the input side of a gearbox with a speed of 250 r.p.m. The gearbox had a control range of 1 in 6.3, thus giving driven shaft speeds between 98 and 610 r.p.m. The output shaft was

connected with a three-speed gearbox, with the ratios 1 to 0.4, 1 to 1, and 1 to 4. The driven shaft of the gearbox was connected with the test shaft by means of a flexible coupling. Between the speed ranges of the gearbox, speed could be varied indefinitely; thus for a shaft of 4 11/32-in. diameter rubbing speeds between 44 to 2,800 ft./min. could be obtained. The motor of the speed-change was controlled by two relays connected with push-buttons at the instrument table. The speed was indicated by an electric speedometer, belt driven from the test shaft. The arrangement of the machine is shown in Fig. 1; Fig. 2 shows the plummer blocks for the supporting bearings of the shaft and the balance beam of the friction balance.

The Test Shaft

The test shaft, 4 11/32-in. diameter, was in steel to D.I.N. St 70.11 unhardened (tensile strength 45 to 59 tons/sq. in.; elongation 10 to 12 per cent.; yield point 22 tons/sq. in. minimum; carbon content about 0.6 per cent.). The supporting bearings had a centre distance of 17$\frac{1}{16}$ ins., and the test bearing lay in the middle. The front end of the shaft was provided with a coolant hole of 1$\frac{6}{16}$-in. diameter running back into the second supporting bearing.

Fig. 3 shows the shaft with the supporting bearings and disc coupling. Near the supporting bearings the shaft was provided with two large anti-splash discs, to prevent the penetration of lubricant from the test bearing to the supporting bearings. Between the two discs was reserved an interval of about 11 ins. for the location of high-duty bearings. The faces on the machine bed for the fixing of the plummer blocks were so selected that centre distances of 26 ins. and 34 ins. could be provided, thus the longest type of oil-ring bearings could be tested.

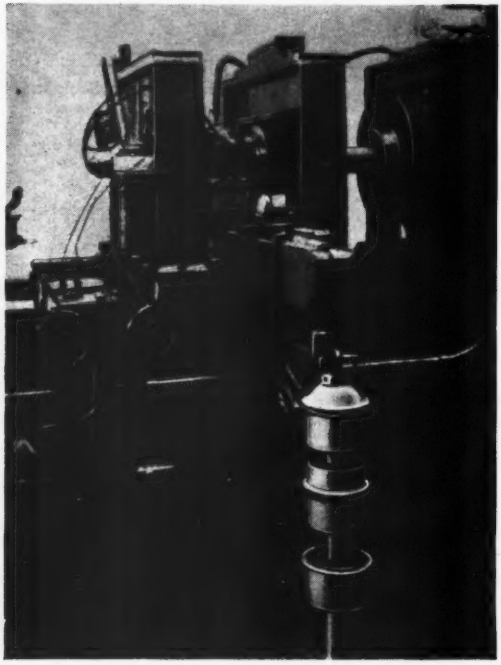
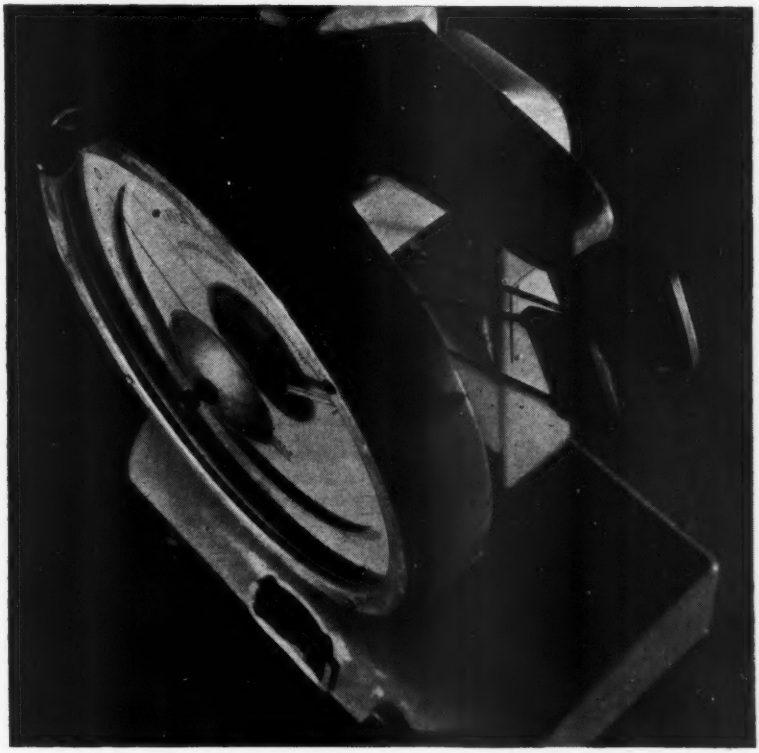


Fig. 2.—Showing plummer blocks for the two supporting bearings of the test shaft and the beam for the friction balance.

Production and Measuring of the Bearing Load

A small hydraulic plant served for generating the bearing load and, simultaneously, to measure it. The pressure fluid employed was water with the addition of an inhibitor.

The pressure fluid acted on two pistons, each 15.5 sq. in. cross-section, mounted in one block. This was situated on a strong plate fixed to the machine bed, and capable of exact adjustment. Fig. 4 shows the block and its mounting. Note the heavy stiffening members on this latter.



Treatment for shock

How different types of plastics withstand mechanical shock is of vital importance in the manufacture and development of these materials. This impact testing machine (IZOD TYPE) is in constant use for the testing of moulding powders. The swinging hammer seen on the right of the picture strikes a specially shaped test piece at an impact velocity of 8ft/sec. The breaking process absorbs energy, the amount of which is automatically registered by a light pointer actuated by the upward swing of the hammer. This is one of a series of controlled routine tests helping to maintain the high level quality of I.C.I. Plastics.

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Pressure was generated by a hand-operated piston pump, having a check valve and a draining valve. A distributor was provided for dividing the pressure fluid to the two cylinders, and was furnished with two check valves for the cylinder and two regulating pistons controlled by hand-operated screw spindles,

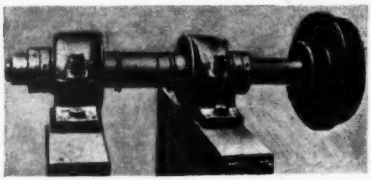

Fig. 3.—Detailed view of test shaft mounted in supporting bearings. The flexible coupling through which the shaft is driven may be seen at the right.

thus permitting accurate control of bearing pressure.

In Fig. 1 at the front end of the machine bed (on the left-hand side) may be seen the hand pump with draining valve and water container, whilst at the right hand will be observed the distributor. An air accumulator of 1.3-gallon capacity equalized the influence of temperature changes and small leakages on the hydraulic pressure.

Three pressure gauges with variable pressure ranges served to check bearing pressure. The gauges could be easily read during operation of the hand pump.

Friction Balance

Fig. 5 shows the test bearing with the centre part of the balance beam. The number of supporting points and links was reduced to a minimum as their friction has to be overcome in the adjustment and, therefore, influences the measured friction torque. One supporting point was represented by the test bearing, the second by the rolling arc, the third by the two hydraulic pistons building up the bearing load. The centres of the two piston glands, the contacting line of the two rolling arcs and the axis of the shaft were arranged in one plane, so that the bearing load caused no moment on the balance beam. At the end of beam (1 m. long) was fixed the dynamometer. The bearing load was transmitted from the two pistons through two pressure pads on to the rolling arcs and the balance beam. The maximum stroke of the piston gland through oscillation of the beam during one pressure range was only 0.0006 in.; this could give rise to only a minute deformation of the glands. The necessary force was reduced through the lever ratios to one fortieth, so that errors in dynamometer readings were small. Two pistons were provided in order to attain, if required, non-axial loads on the bearing. The upper rolling plate was fixed to the lower side of the beam; four adjusting screws were provided for lateral adjustment. The relative position of the two rolling bodies was secured by steel balls.

To permit free axial self-adjustment of the bearing, the upper ends of the supports were not fixed to the lower rolling plate, but were provided with a "head," the upper side of which formed a ground cylinder of about 24 ins. radius.

The cylinder faces abutted to the plane

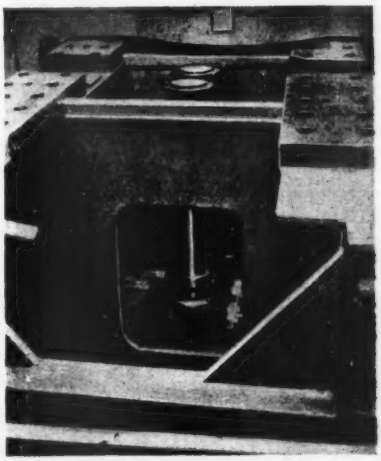

Fig. 4.—Close-up view of the hydraulic apparatus for generating bearing load. Note method of mounting on bed of testing machine.

face of the lower rolling body in such a way that the cylinder axes were perpendicular to the plane of the shaft centre. The supporting heads were also secured in position with reference to the rolling heads, by means of two steel balls.

All rolling bodies were well hardened, the cylinder face of the lower rolling body being ground to a radius of 28 ins.; the axis of the cylinder passed through the centre of the two piston glands. The cylinder face of the upper rolling body was ground to a radius of 11⅜ ins., and its axis coincided with the axis of the test shaft. When the cylinder was correctly adjusted, the bearing load could exert no moment on the balance beam. To limit axial movement of the beam, two rollers

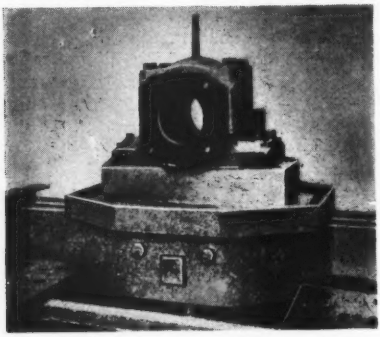

Fig. 5.—Centre portion of beam of the friction balance, showing test bearing in position.

were provided, which, however, did not come into action if the test bearing were in the correct position.

In the tests hitherto carried out, even bearings of 16½ ins. in length could be adjusted correctly, in spite of the fact that the two supports had a centre distance of only 5¼ ins. The two supports with the cylindrical heads can be seen in Fig. 4.

Measuring the Friction Torque

An important assumption for the correct recording of torque during all variations of friction is that the inertia forces caused by movement of the beam be kept as low as possible, i.e., moving masses as well as their measured path must be kept as small as possible. Both requirements could be fulfilled by dynamometers developed by Allgemeine Elektricitäts Gesellschaft. The masses in movement in these instruments were so small that, compared with those of the friction balance, they could be neglected; the greatest path was only 0.002 in. As shown in illustrations, Figs. 1 and 2, the three dynamometers were arranged in a column, thus permitting change from one to the other without interrupting the test. The dynamometers' measuring range was from 0 to 16 lb., 0 to 80 lb., and 0 to 400 lb. The upper dynamometer was connected by an oscillating link with the 1 m. beam.

Forces acting on the dynamometer were transmitted electrically to three recording machines, with maximum tracing width of 4¾ ins. and paper speeds of 2⅜ and 9½ ins. per hour.

Measuring of Temperature

A thermometer near the instrument board served for measuring the room temperature. The temperature of the lubricant fed to the bearing was measured by a thermocouple, checked by a direct-reading finely graduated mercury thermometer. The temperature of the lubricant coming from the bearing was measured again by thermocouples built into the sumps at both sides of the bearing. The temperature of the bearing body could also be measured by a thermocouple arranged in such a way that the hot end was only a few millimetres below the middle of the lower brass.

The temperature in the bearing surface was measured by two thermocouples inserted at a fixed distance at the lowest point of the lower bearing brass, the hot junctions being at the same level as the bearing surface. The cold junctions of all couples were immersed in vacuum flasks of iced water. Temperature recorders were attached to all thermocouples.

Other Measuring Devices

Two dial instruments served to measure changes in the position of the balance beam, and were fixed at a dis-

(Continued on page 206.)

A.A. Command use Plastics . . .

"Before I joined up I worked for a Plastics firm. Little did I think when I was moulding radio cabinets—motor parts—beakers—boxes and suchlike things, that one day I would be setting a plastic fuse cap to an anti-aircraft shell, to knock the Jerries out of the skies. Here's hoping that all of us before long will be back in our old jobs again—making things for the wife, the kids, and the home, and all the other products to which plastics are now applied."

Note.—Our illustration also shows a shell transit plug—another of the many applications of plastics to meet war-time needs.

De La Rue Plastics Ltd
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PRODUCTION NEWS

Raw Materials, New Plant, Works Organization, Control Apparatus, Research, Personal and Trade Notes

BRITISH INDUSTRIAL PLASTICS, LTD.—In a recent statement to the shareholders of his company, the chairman, Mr. Kenneth Chance, stated, with regard to technical matters, that the company has improved its methods of manufacture of moulding powders and has, in addition, after prolonged research and experiment, found a plasticizer for aminoplastic resins and moulding powders and has applied for patent protection for its use in this connection. This plasticizer will be used in large quantity and plans are in hand for the installation at Oldbury of plant for its manufacture on a substantial scale under a process for which application has also been made for patent protection.

Aminoplastic moulding powders have advantages which are well known, but are subject to certain defects which place definite limitations upon their adoption for purposes for which, otherwise, they are well suited. This new invention will broaden the market. The plasticizer will also reduce the cost of manufacture of the most valuable of the cements made by the company and thus help to maintain after the war, and ultimately extend, the large production which is at present confined to work of the highest priority. The plant for the manufacture of this plasticizer will be considerably more costly per unit of production than any yet installed by the company.

British Industrial Plastics, Ltd., will also install new plant to improve efficiency and to provide automatic control over press operations. With regard to the need for cheap power, Mr. Chance said:—

"I must now deal with what I regard as the most important question of all affecting the business of this company which looks for great expansion of its export trade—the coal situation. When I joined the company more than 40 years ago I used to place contracts for boiler slack at 4s. 6d. per ton delivered to the factory. In June, 1939, similar slack cost 17s. per ton. Now slack, which is certainly no better in quality, costs us on the average 40s. per ton delivered.

"The raw materials of your business, other than coal, are urea, formaldehyde, melamine and solvents or plasticizers. All these are organic chemicals, which means that they are based upon carbon as the one essential ingredient common to all. The materials from which they are made can in some cases be obtained from the distillation of coal, but, more generally, are produced by synthesis, which requires power in the form of heat or pressure, or both. Now the natural source of supply, both of carbon and of power in this country, is coal. I know the prices at which the raw materials upon which your business is based can be purchased abroad, but I also know that I cannot expect them to be made here and sold at competitive prices so long as manufacturers abroad can obtain electric power at a fraction of its cost in this country. The raw material for the manufacture of melamine is not made here because it is derived from calcium carbide, and under present conditions it is impossible to manufacture carbide at a cost remotely comparable to that at which it can be produced abroad, where electricity can be generated cheaply either from water power or from coal. I have brought up this subject before, both in my annual statements to you and elsewhere, and shall continue to do so in the hope that one day the Nation will awake to its danger.

"It is hard to believe that the best way of generating electric power in England and Wales is by digging coal from the mine and transporting it, often for considerable distances, to be burnt under boilers for conversion into steam for driving turbines connected to generators, then building huge cooling plants and pumping water through them in order to get rid of the heat which the turbines cannot use. By this method all the valuable by-products of coal are destroyed and about 60 per cent. of its effective heat is wasted."

GAUGE AND TOOL MAKERS' ASSOCIATION.—The export committee of the Association has prepared a specimen agreement for the employment of overseas agents which interested member-firms may either adopt in its entirety when entering individually into arrangements with firms or persons overseas or may use as a guide in the drawing up of their own agreements.

Copies of the specimen agreement will be

available to the readers of your esteemed journal on application to the office of the Association, Standbrook House, Old Bond Street, London, W.1.

NORTH WALES FACTORY. — Mr. Joseph Salzedo, of Llandudno, an industrialist who has declared his intention of contesting the pending Caernarvon Borough by-election as an Independent, has stated that negotiations were in an advanced stage for a site in North Wales for a plastic goods factory. There was no reason, he declared, why work should not be provided for 10,000 people.

[EDITOR'S NOTE: We do not know if this figure is correctly reported, but it seems absurdly high for a plastics producing factory.]

PLASTICS IN MANCHESTER.—" The Evening Chronicle " of Manchester reports that there is a demand for big-scale development in the Manchester area of the productive side of the plastics industry, which will be an outstanding feature of the report on the post-war planning of industry in Greater Manchester, now being prepared by the Manchester and Salford Trades Council.

SCIENTIFIC INSTRUMENT MANUFACTURERS.—This Association announces that Mr. W. Bowen has generously presented to the S.I.M.A. a substantial capital sum, the income of which he wishes to be devoted towards the encouragement and development of invention, design, research, processes and manufacturing technique in the Scientific Instrument Manufacturing Industry.

The Council of the S.I.M.A. have drawn up a Deed of Trust under which the income from the trust fund is to be devoted each year to prizes to be awarded to the employees of members submitting papers fulfilling the objects of the trust. Mr. W. Bowen is governing director of Bowen Instrument Co., Ltd., Cables and Plastics, Ltd., and Bowen Research.

LAC RESEARCH.—We have received from the London Shellac Research Bureau four pamphlets covering recent work in this subject. Three deal with " a process for the manufacture of Dewaxed Lac," " Determination of Volatile Matter in Lac," and " Lac-Ethyl Cellulose Lacquers," all by Dr. B. S. Gidvani and N. R. Kamath, B.Sc. The fourth is a compilation of abstracts bearing on Shellac research literature for January 1 to December 31, 1944.

MR. S. B. TURNER, who has been with BX Plastics, Ltd., since 1931, has now joined the Expanded Rubber Co., Ltd., of Mitcham, where he will occupy the position of sales manager. Mr. Turner will still be closely concerned with plastics, however, for the Expanded Rubber Co., Ltd., is a subsidiary of BX Plastics, Ltd. Its activities cover the development not only of expanded rubber products but also of expanded plastics.

MR. B. J. HAMLIN, who has been associated for many years with F. A. Hughes and Co., Ltd., now joins the staff of the Airscrew Co., Ltd., of Weybridge. His place at F. A. Hughes and Co., Ltd., is taken by **MR. R. K. HARTLEY.**

E. F. LOUGEE.—We regret to announce the death of our very amiable correspondence friend who was for so long Editor of " Modern Plastics," of U.S.A., and who at the beginning of the war resigned to join the Advisory Board of the Plastics Industry Technical Institute in California as its Chairman. His frequent letters to us were always amusing to read, but were also full of information about what was being done in the U.S.A. In them, too, he showed himself a good friend to this country.

Society Meetings

S.C.I. (PLASTICS GROUP).—A lecture on " Fabric-base Plastics " will be delivered by Dr. K. W. Pepper and Dr. F. T. Barwell on April 13 at the Chamber of Commerce, New Street, Birmingham, at 6.30 p.m. The Birmingham I.C.I. Section is invited to attend.

I.P.I., SOUTHERN SECTION.—Dr. A. Caress, of Imperial Chemical Industries (Plastics), Ltd., gave a lecture on " New Forms of Acrylic Resins " to 150 members of the Southern Section, at the University College, Southampton, on Wednesday, March 28, 1945. Dr. Caress gave a fascinating talk about the newer application of Acrylics in such fields as " Radar," aircraft, optical, surgery, dentistry, building, domestic articles and fibres for textiles. The audience were able to see for themselves a whole range of samples of this new application.

For the benefit of members of the Institute it is hoped that a full report of the paper will be published in the transactions of the Institute of the Plastics Industry this year.

Planned Mould Maintenance Service Aids Economical Production

Part XI (Contd.)

By W. M. HALLIDAY

FIG. 3 shows diagrammatically another useful and very positive form of interlocking control mechanism which may be applied to a mould construction to ensure the movement of cores at the specified times during moulding cycle. As will be seen, the movable block is provided with three horizontally disposed core rods which have to be withdrawn only when the moving block has reached its extreme open position.

These core rods, A, B and C respectively, are extended so as to overhang the side face of the movable block, and each rod is machined with a pair of diametrically opposed flats in order to form a narrow parallel portion.

To the stationary mould block is permanently secured a specially shaped slotted interlock rail, this being located in a shallow parallel slot in the block to prevent displacement. This rail is provided with three long parallel slots, each being wide enough to pass freely over the slotted portion of the core rods. At the left-hand end of this rail it will be seen that the three slots terminate in circular holes, the diameter of these latter being slightly larger than that of the core rods. These clearance holes or ports serve to allow the rail to be placed in position, and are mainly for permitting the core rods to be withdrawn when movable block has been opened to the requisite point.

The functioning of this interlock rail mechanism will be apparent from inspection of the diagram. With the three cores A, B and C in their closed position, the elongated slots will be passed over the flattened portions which actually form working slots over which the elongated slotted rail can slide. The heavy lines show the moving block in its closed position, from which it will be seen that the three cores cannot move outwards from the movable block because of the sides of the rail.

Thus during the injection shot the cores are effectively retained, and similarly held until the blocks are completely opened as shown by the heavy broken lines at the left hand. In this position it must be observed that the cores A and B are exactly in line with their respective clearance ports, and in this position only can readily be withdrawn.

But core C cannot be withdrawn until the first two have been detached, because the horizontal centre distance X is intentionally made longer than the distance Y, which is the spacing of the core rods

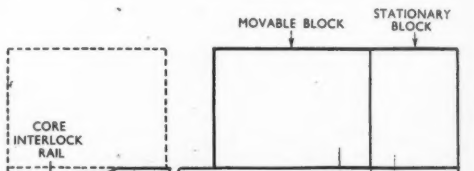


Fig. 3.

themselves. Hence, after cores A and B have been removed and the mould can be further opened a slight amount, the remaining core C may safely be withdrawn.

To guide the rail in cases where this latter is of long length, a slot should be machined across the end face of the movable block as indicated in the dotted lines. This will impart much steadier and rigid retention of the interlock rail and prevent undue vibration on the other end and its fastening screws, etc.

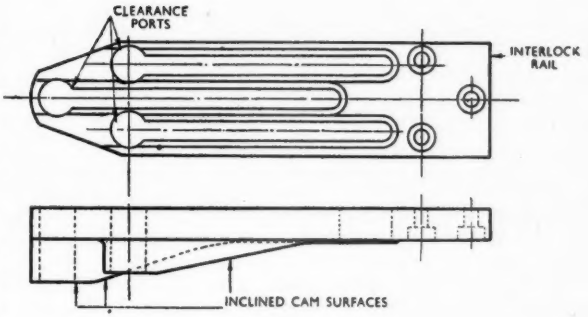


Fig. 4.

As will be apparent, this form of interlock for core rod location and withdrawal is capable of giving effective control over rod motions in a wide variety of circumstances. If, for example, it is desired to remove one core rod immediately after an injection shot and prior to any mould block opening, then all that is necessary is to provide an additional clearance port in the appropriate elongated slot in the rail.

Thus, by this means, core rods may be locked for any portion of the movable block's opening travel, and any point can be selected for withdrawal of the cores. It can also be adapted so as to deal with a larger number of cores. Similarly, in the case of threaded cores which have to be rotated for their removal, this type of interlock rail can be employed with great success. The flattened slots provided on the core rods should be made a snug sliding fit within the elongated slots of the rail to prevent undue rotation of rods. The rods will only be capable of being rotated for extraction when the mould block has opened sufficiently to bring a clearance port opposite the rod as already described.

Such a rail can, of course, be used on any side of the mould block, or would work equally well if inclined at an angle, as is often necessary with some core-withdrawing arrangements.

Its use should entail scant attention from the maintenance engineer, especially if the rail is carefully and accurately made from good-grade steel and afterwards carefully case-hardened on the sides of the elongated slots which would have to withstand most wearing action. The ends of the cores would also need to be hardened and accurately machined. Apart from maintaining in a clean and well-lubricated condition, there should be little other attention required to ensure their prolonged smooth and reliable working, and the design is recommended as one well proved by practice.

Fig. 4 illustrates a very useful modification which may be made to the interlock rail described in connection with the device shown in Fig. 3.

The object of the modification to the interlock rail is to provide automatic means on the rail itself for effecting the withdrawal of the cores. This is accomplished by making the whole front surface of the rail, or those surfaces immediately surrounding the elongated slots, inclined in the form of cams.

With an interlock rail of this type in use as the movable block opens the slotted ends of the cores travel along the elongated slots in the rail, and also the head portion of the rods will travel along the inclined front faces of the rail, thereby causing them to withdraw from the moving block.

It will be readily understood that any convenient degree of inclination can be afforded to the front face of this rail, whilst suitable dwell periods may also be provided as required by coring conditions.

Where this type of interlock rail is employed it will be necessary to provide for well-hardened cam surfaces to withstand wear effects, and, of course, the degree of " lift " possible will be somewhat limited. Thus, cores having long draw cannot satisfactorily be operated in this fashion. But the slow degree of taper enables a very powerful wedging action to be obtained which will be found sufficient for withdrawing quite large-diameter cores. The rail can, of course, be applied for use in any plane, and the clearance ports for the complete extraction of the core rods can also be positioned at will along the length of the rail as in the previous instance.

Indeed, this kind of interlock mechanism by means of a slotted rail is one capable of great flexibility, permitting a wide range of core extraction operations to be controlled with little trouble. Installation and upkeep costs are small.

Yet another important form of safety mechanism is illustrated in the sectional drawings shown in Fig. 5. This safety device has been developed by the writer in order to ensure that the mould blocks cannot be either opened or closed whilst the vertical core pin is in the moulding position, the mechanism allowing the core or cores to be brought into correct location in readiness for an injection shot only when the mould blocks are closed.

Referring to the drawing, it will be seen that it is essential that the vertical core pin be raised before the main blocks are parted, because the extreme lower end of the core actually passes for a short distance into the large fixed core secured within the stationary block. If the mould blocks were to be opened before the raising of the small vertical core, this latter member would suffer damage.

This, in fact, frequently occurred with this mould construction which was first operated without the core safety device, and not only was it found that the small core became damaged, but also the locating cross hole in the side of the fixed core of the mould also became badly bruised and pulled out of shape.

It was to eliminate such troubles that the safety arrangement was inaugurated. The top edge of the stationary block was machined with a narrow groove extending for the full length of this part and lying dead parallel with the parting line edge of the block, as shown in the lower view.

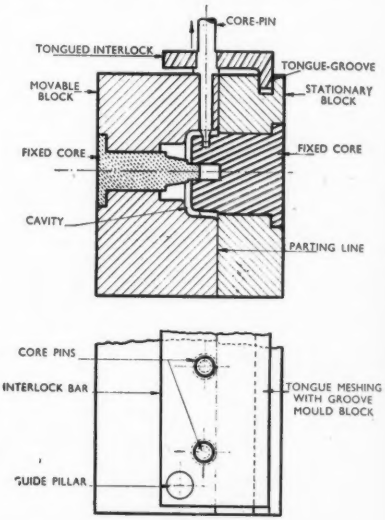


Fig. 5.

To the shank of the core pin normally extending above the top edge of the movable block was securely fixed a tongued interlock bar, the tongue portion of which was made an easy fit within the groove machined in the fixed block. The depth of tongue provided on the right-hand end of this member was made about $\frac{1}{4}$ in. longer than the amount of core pin projection within the mould cavity.

The illustration shows the position of the tongued interlocking bar when the core pin is in its moulding or closed position. It will be seen that the tongue portion of the bar passes well down into the groove in stationary mould block.

If attempts were made to open the

mould blocks, such movement would be resisted by the strong tongue bar because of its engagement with the stationary block. Thus, before the blocks can be opened the vertical core member must be raised out of harm's way.

Similarly, when closing together the mould blocks, should the core pin be in its lowest position the tongued portion of the interlock bar will contact against the parting-line surface of the stationary block, thereby effectively preventing the blocks from being closed until the core has been lifted. The distance from the centre line of the core pin to the end face of the tongued portion of the bar should be long enough to arrest the travel of the movable block sufficiently early to prevent any contact with the depressed core pin with the end of the fixed core in the stationary block.

As will be seen from the partial lower view, more than one core pin may be safeguarded in this manner. Where a number of cores have to be raised, provided they all move in the same plane, one long tongued interlock bar may be employed. The dimensions of the tongue and groove in such circumstances would have to be such as to suit the longest core-drawing movement required.

This type of safety device will be found especially valuable in controlling the location and movement of slender core pins, which are otherwise liable to suffer damage from jamming with cross-located cores. It has also been applied with equal success to some ejector gear to determine the travel of the ejector rod rail. In fact, numerous applications will undoubtedly suggest themselves. It can be employed upon core rods moving both horizontally, vertically, or at an angle, although, be it noted, in the latter case the groove in the stationary block would have to be cut in at the same angle as that of the core draw, and not parallel with the parting-line surface of blocks as in the present instance.

Retention of Movable Core Slides

In the case of mould constructions having moving core slides, which carry a number of core pins, it is very common practice to effect the opening and closing of such slides by means of angularly disposed pins attached to the stationary block, which engage similarly inclined holes through the slide, which are thus caused to move inwards as the mould blocks are closed.

One of the chief objectionable features associated with this form of core-slide operation lies in respect of the retention of the slide in the open or raised position after the movable block has travelled so far as to bring the actuating pin out of engagement with the core slide. In this condition, unless some means are provided for holding the core slide it will simply fall by its own weight to the bottom of its guides, and should the mould blocks be closed a very serious jam would result, which often occurs, in fact, and entails damage and breakages to all kinds of mould members.

Fig. 6 illustrates a very common method employed by mould engineers to secure retention of movable core slides. This simply comprises a spring-loaded ball housed in a suitable hole in the movable block immediately behind the core slide to be held. This ball is held into engagement with a dimple or small hole formed in the rear face of the slide.

This is a very common method and, whilst it is inexpensive and simple, it is in practice far from satisfactory, especially from the maintenance engineer's point of view.

Quite apart from the possible failure or weakening of the compression spring which is usually employed, there are several other snags to be noted. Thus, after a time it will be found that the repeated working has caused the ball to wear the sides of the dimple in the back of the slide to oval shape, as is shown in the right-hand upper view, Fig. 6. When this occurs it means that the core slide is not smartly and firmly held in place, but can be moved slightly up and down, due to the elongation of the engaging dimple in which the ball resides.

Moreover, there will be a tendency for the ball to wear a groove in the back of

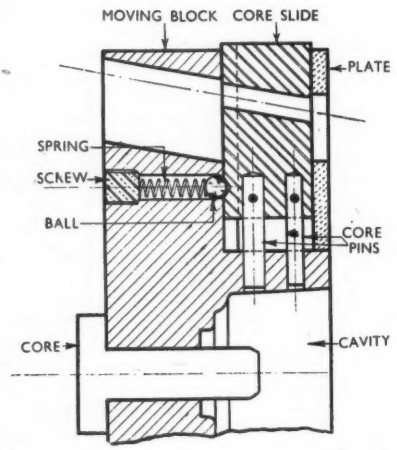
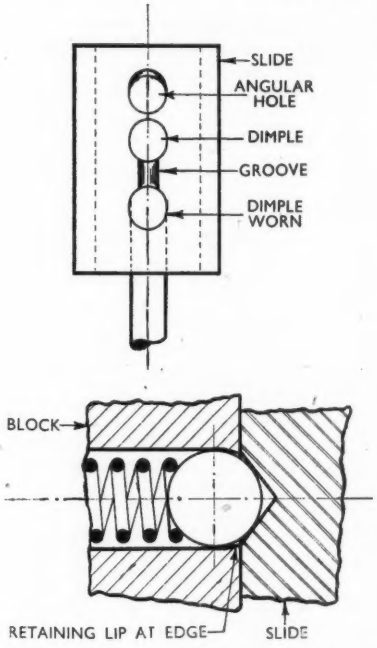


Fig. 6.

the slide, between the two dimples where these are provided to give two location points to the slide. Such a groove will tend to cause stiffened working of the slide.

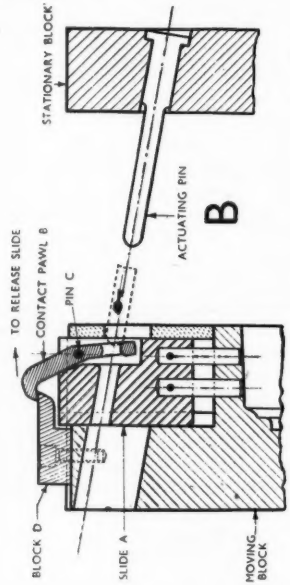
Then, again, as regards the housing of the ball within the bored hole in the movable block. Here, again, some means will have to be provided to prevent the ball from passing clean out of its hole when the core slide is removed. This is usually accomplished by drilling the extreme inner end of the hole slightly smaller in diameter and thereby leaving a tiny lip projection all round the edge of the hole, large enough in diameter to allow sufficient projection of the ball beyond to engage with its dimple, but small enough to prevent the ball from passing entirely through.

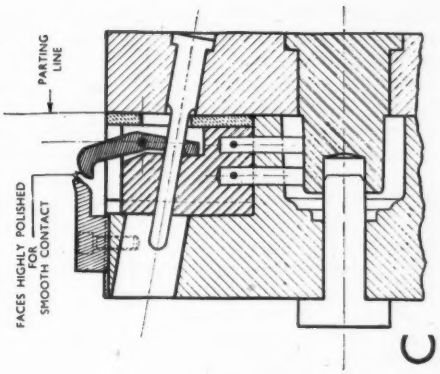
But because this restraining lip portion must necessarily be made so small, if there is heavy load upon the core slide, or stiffened working of the ball in contact with the back of the slide, there will be a tendency to wear away the restraining lip, so permitting the ball to move about too much within the mouth of its hole. Here, again, is another possible source of misalignment and unsatisfactory retention. This is shown in the lower view.



Further, such a mechanism would be apt to become choked with dirt, excess oil, etc., which, in time, would necessitate dismantling for cleaning purposes. Mainly, then, it will be found that this method does not ensure positive and strictly accurate location of a slide, especially after some usage, and often leads to the misplacement of a slide in relation to its actuating pin with more or less serious results. In the case of a mould capable of fast working, the operator may not always observe that a vertical core slide has dropped a short distance after the actuating pins have been withdrawn.

To overcome all these troubles, and to provide for positive location and retention of a core slide without recourse to springs at all, a type of simple mechanism has been designed and used with commendable results. This is clearly shown in the three partial sectioned drawings marked A, B and C respectively in Fig. 7.





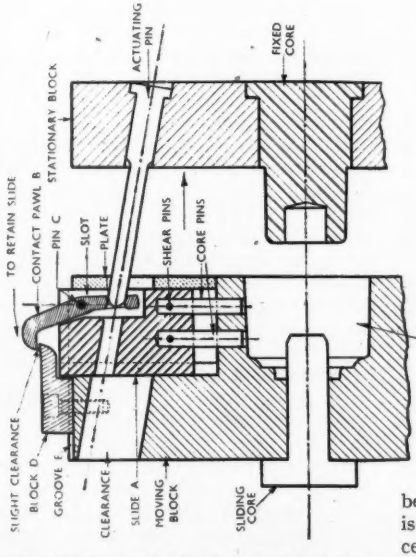


Fig. 7.

As will be noticed, the mould design in this instance consists of a vertically located core slide which carries two core pins which have to pass into the mould cavity and rest upon a main fixed horizontal core attached to the stationary mould block. It is possible with this construction to move the cores out of the finished moulding simultaneously with the opening movement of the mould blocks, hence the core slide is operated by means of an inclined actuating pin secured into the stationary blocks.

By referring to these drawings it will be seen that the vertical core slide (A) is provided with a machined slot in its front face made wide enough and of sufficient depth to house the swivelling contact pawl (B), which latter member is fulcrumed so as to swing very freely over the pin (C), which passes through the sides of the slide and is secured therein against endwise movement by any suitable means.

This pawl B is shaped as shown, from which it will be gathered that the upper end portion is suitably offset to the left of the vertical centre line of the fulcrum pin. By overhanging the main weight of the pawl in this manner it always possesses a tendency to swing over towards the rear face

of the movable block. It will also be appreciated that this pawl will move up and down with the core slide.

The lower or tail portion of this pawl is drilled through with an angular hole exactly in line with the angular hole in the core slide, and the hole is afterwards barrelled out as shown to obviate any binding action on the actuating pin during operation of the core slide when the contact pawl has to occupy slightly different positions as will be explained later.

The upper end of this pawl is turned over in the form of a tooth, with the flat underside portion inclined as indicated. This portion of the pawl is shaped thus for engagement with the inclined upper face of the block D, which is secured within a shallow groove E machined along top face of the movable block. This block is located quite close behind the slide as shown.

Section A in Fig. 7 shows the movable block partially opened with the actuating pin in the stationary block just about to break engagement with the barrel-shaped hole in the contact pawl B. It will be noted that the core slide has been lifted sufficiently to cause the upper toothed end of the pawl B to be slightly above the top face of the block D. The withdrawing movement of the actuating pin serves to impart a slight anti-clockwise swivelling motion to this pawl, thereby bringing its upper toothed end well over edge of the block D. In this position the core pins are well withdrawn out of the mould cavity.

Referring to the illustration B this shows the mould blocks in their extreme open position and with the actuating pin completely out of contact with core slide or its pawl, clearly indicated by the thickened line. The core slide, it will now be seen, has dropped slightly, causing the topmost toothed end of pawl B to bear down upon the upper edge of block D, which action causes the core slide to remain stationary. In this final retaining position the ends of the core pins attached to lower end of the slide are still well clear of the cavity wall, thus permitting ejection of the completed moulded article.

The degree of inclination to be imparted to top edge of the fixed block D and the mating underside of pawl B must, of course, be found by testing, and a few tests and perhaps removal of a slight amount of material prior to hardening of these members will usually suffice to secure the correct angle to give adequate non-slipping grip between the two parts.

When closing the moulds the operation of the pawl B is entirely automatic and is performed by the normal contact with the rounded end of the actuating pin in the following manner.

Still referring to illustration B, Fig. 7, the approaching closure of the mould blocks is indicated by means of heavy broken outline of the actuating pin, which is shown just about to make contact once again with the barrel-shaped hole in tail of pawl B, as the movable mould block brings the pawl up to end of the pin.

Since the tail end of the pawl B has been swung round slightly after breaking engagement with the actuating pin during mould opening the barrel-shaped hole will lie slightly out of correct line with end of pin as shown. Thus before the pin can enter the hole through pawl this latter must be moved round in a clockwise direction a slight amount, which movement is sufficient to bring the upper toothed end clear of the fixed block D. When this occurs the slide is free to descend under action of the inclined pin as the end of pawl is then cleared of all contact with the block.

The final position of these respective members is shown in the third illustration C, which shows the mould blocks completely closed in readiness for receiving an injection shot. As will be noticed the pawl B has now been swung around so that its lower tail portion is in contact with the bottom of the slot in the core slide.

At one point during the raising of the core slide the upper edge of the toothed end of the pawl B will actually make slight contact against the end face of the block D, and to ease the frictional contact

occurring then it is necessary to polish the surfaces of these two members very smooth.

Admittedly this safety device works best in locations similar to the one here illustrated, but it can readily be modified so as to work equally well in holding a core slide against dropping clean out of the lower edge of a mould block. In such a circumstance, of course, it will be necessary to alter the shape of the pawl head, making this stepped so as to engage on its upper surface rather than its underneath one, whilst the holding block also would have to be similarly treated.

This form of safeguarding device will be found extremely useful in that it completely obviates the use of springs and balls, and, moreover, is positive, reliable and capable of working at fast speeds without trouble. So far as the maintenance toolmaker is concerned there need be little to cause trouble, if the pawl is very carefully hardened and polished on vital points, and well fitted so as to be a free, but not a sloppy, fit within the slot in slide and around the fulcrum pin.

Another useful advantage lies in the fact that all members are easily accessible, and the core slide can readily be completely withdrawn, together with the entire safety mechanism, simply by removing the block D. The pawl should be located sufficiently well away from the mould cavity or cavities to preclude an overflow of excess plastic material into the pawl slot, etc., otherwise stiffened working of this latter member may result.

These very useful safety devices by no means exhaust all the numerous applications of similar mechanisms which could be described, but perhaps sufficient has been mentioned to indicate to mould designers and engineers general features of some valuable arrangements which can easily be adapted into conventional mould constructions.

In concluding this section it is once again emphasized that both mould designer, engineer, and maintenance toolmaker can very successfully co-operate in endeavours so to fashion mould designs that all predictable misuse, or accidental damages during actual production operation can be largely avoided, which is, as already stressed, perhaps one of the chief ways whereby maintenance services can be kept at a minimum when once the mould is placed into use.

In the next continuing section of this subject of mould safety measures, etc., the author hopes to deal with the somewhat involved and rather imperfectly understood question of venting of moulds to allow escape of air. Not only does effective air venting make for improved forms of moulding, and smoother production, but it also promotes the safe usage of the moulds. Where venting facilities are poor, numbers of operational troubles are apt to arise, which in their turn may lead to damage and breakage of mould components.

The technique of efficient venting will then be discussed, and a number of illustrations afforded to indicate how this aspect of mould design and construction may be planned to eliminate mould faults and breakages, or excessive wear.

In further sections the author will deal with mould designs incorporating the use of inserts, and describe various constructions in which insert location and retention facilities are employed, noting specially the numerous maintenance features connected therewith, together with improved or preferred forms of apparatus which can be adopted in order to reduce operating troubles, as well as ensuring smoother working service.

Canadian Practice Bomb

M. Wintrob and Sons, Ltd., and Reliable Plastics, Ltd., both Canadian companies, are moulding Lumarith (cellulose acetate) caps and heads which are fitted to the paper board cartridges used for target training by the Royal Canadian Air Force. The cap and head are treated with a cellulose acetate cement into a very firm jointing.

The hollow thin-walled Lumarith head replaced a solid plastic head on which contraction on emergence from the die could not be controlled to a satisfactory degree. This hollow type can be held to a tolerance of plus or minus 5/1000 in.

Resinoids and Other Plastics as Film Formers

By B. J. BRAJNIKOFF,
Consulting Electrical Engineer

XXIV.—Synthetic Coatings Based on Acetylene (Contd.)

AMONG the works on synthesis of new organic combinations on an acetylene base the first place undoubtedly belongs to that of Favorsky. This great organic chemist, a pupil of Mendeleeff and Butleroff, began an experimental study, which proceeded not in a prescribed direction, but formed the basis of an entirely new department of organic chemistry—the study of isomeric transformations of acetylene and diethylene derivatives.

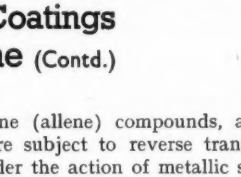
The foundations of this work have been given by Favorsky in his Master's of Science thesis in 1891. This was extended further in his Doctor's thesis of 1895, to compounds containing a carbonyl group and to derivatives of an oxide character.

Structural Variability of Organic Combinations and Lability of Bonds

Both the above-mentioned Favorsky's monographs contain a wealth of experimental data showing the variability of structure of organic combinations, particularly those comprising multiple bonds, without alteration of the empirical formula of a substance, and, consequently, demonstrating the lability of these bonds serving as a source for intra-molecular regroupings, as well as, generally, the ability of unsaturated compounds for reactions.

In all Favorsky's works the molecule of a definite composition is regarded not as a fixed, rigid structure, which can only be turned into a substance of different nature under the action of chemical reagents, but also as a variable formation capable for transformations because of its own internal energy, which merely needs to be actuated by forces from without.

Thus, acetylene derivatives, under the action of alcoholic alkali, regroup into diethylene (allene) compounds, and the latter are subject to reverse transformation under the action of metallic sodium, according to the scheme:—



Favorsky does not restrict his postulate to the statement of synthesis of new substances and established "rules," that govern the observed isomerizations, but attempts to give them a generalized interpretation.

His viewpoint, as expounded in his dissertations, is that phenomena of isomerization are the result of a series of chemical reactions, in particular of addition reactions of the component parts of some fairly simple molecules, at the points of multiple bonds, followed then by abstracting the same or other molecules at different points.

Thus, in the case of keto-alcohols, Favorsky explains the observed isomerizations with the transposition of the carbonyl towards the end of the normal fatty chain, by the hydration of carbonyl group, then by the formation of oxide and by the interchange of the positions between hydrogen and hydroxyl in the case of secondary alcoholic groups, and those between hydrocarbon radical and hydroxyl, in the case of ternary alcohol groups.

Hence, according to Favorsky, these reactions represent intra-molecular reactions of oxidation and reduction. As he showed, such reactions can also take place between the two molecules of aldehydes

either of an identical or a different constitution. This explanation of the mechanism of isomerization based upon vast experimental data led Favorsky in 1928 to a remarkably elegant interpretation of the mechanism of alcoholic fermentation[292] corroborated by still later investigations,[293] and affording, among other things, the possibility of finding the method for averting the formation of glycerine during the fermentation, by the addition to the fermenting liquid of 2 per cent. of acetaldehyde. Another equally elegant application of Favorsky's theoretical studies to the interpretation of natural processes is the synthesis of terpenes by means of the electrolytic reduction of dimethylacetylenylcarbinol in sulphuric acid medium.[294] If we presume that the source of formation of terpenes in plant life is leucine, transformed into isoamyl alcohol, and, further, into isovaleric aldehyde, we approach, apparently, very closely the initial process of terpene synthesis by Nature. In addition, it should also be noted that, as demonstrated by Favorsky, dimethylvinylcarbinol, by splitting off water, gives rise to the formation of isoprene, a hydrocarbon constituting the basis of natural rubber.

As is seen from the above, the reactions of isomerization of hydrocarbons (as well as their haloid derivatives) is interpreted by Favorsky exclusively as intermediate reactions of addition and abstracting of alcohol, water, hydrogen halides, etc. In the isomerization of keto-halides, oxyketones, oxyaldehydes, etc., he also presumed a direct migration or interchange in position between hydrogen, hydrocarbon radicals, hydroxyls and halides.

Isomerization and Polymerization of Unsaturated Hydrocarbons

The first hypothesis of addition and abstraction reactions has proved to be very fruitful in interpreting the observed phenomena. However, with the lapse of time, there began to emerge an ever-increasing number of exceptional cases, which induced Favorsky to revise his theoretical standpoint and to abandon the foregoing hypothesis, replacing it by the treatment of isomerizations as intramolecular transformations caused by the catalytic action of external reagents and tending to proceed in the direction of structures possessing the minimum of internal energy.

Notwithstanding the fact that the original Favorsky's hypothesis could not explain all the observed phenomena, it has, as stated earlier, played a great role as a working guide in experiments and thus led to many discoveries.

As to Favorsky's second and latest interpretation of isomerization in its application to the so-called tautomeric or mesomeric combinations, it is definitely consonant with the theory of quantum resonance, which has been successfully developed in recent years by Pauling, Schwarzenbach, and others.

The greater half of Favorsky's scientific activities took place in the conditions of pre-revolutionary times, when in Russia the chemical industry, especially its organic branch, was developed but little. Therefore, investigations of Favorsky and his students had a purely theoretical character, there being but little scope in the country for their application. But like the work of many other Russian chemists (Zinin, Kutcheroff, Beilstein, Kurbatoff, and others) they were taken up by enterprising industrialists abroad and became a basis for the new fields of chemical technology. Thus, for example, the simple method for obtaining the simple ether of ethyleneglycol (dioxan), discovered by Favorsky, has been for a long time widely used in the various countries for the production of this almost universal solvent.

The studies of Favorsky in the sphere of isomerization and polymerization of unsaturated hydrocarbons furnished a wealth of information for the development of different methods for the manufacture of synthetic rubbers and kindred plastic materials.

It should be pointed out that the creator of the first industrial synthesis of rubber in Russia, the late Academician Lebedeff, was Favorsky's pupil, who, in

all his works (initially also of purely theoretical nature), including the technical development of rubber synthesis, has utilized not only the general ideas of his teacher, but many experimental data accumulated by the latter as well, an aspect which has been frequently emphasized by Lebedeff himself in his "Researches on Polymerization of Diethylene Hydrocarbons."

Favorsky's Reaction in Relation to Synthesis of Rubber-like Plastics

Discovered by Favorsky at the beginning of the current century, the fruitful reaction of addition of phenylacetylene to acetone has quite obviously served as a prototype of Merling's method for obtaining dimethylacetylenecarbinol (from acetone and acetylene itself) and, from it, of dimethylvinylcarbinol and, further, of isoprene, from which Germany during the last war made considerable quantities of synthetic rubber.

Again, the reverse reaction of addition of alcohols to acetylene, discovered by Favorsky more than 50 years ago, has been employed abroad as a basis for the development of the method of manufacturing simple vinyl ethers of various oxy-derivatives:

$$R \cdot OH + HC \equiv CH \longrightarrow R \cdot O \cdot CH = CH_2,$$

which serve as raw materials for the synthesis of a vast range of interesting and valuable products capable of polymerizing into plastics, resins, etc.

Many of the foreign patents granted for the carrying out of the aforesaid reactions literally repeat the principles of Favorsky's works, merely amplifying his formulations by technical details.

The great Russian Revolution of 1917 introduced unprecedented changes into the circumstances of Favorsky's works, as those of other Russian chemists, and created exceptionally favourable conditions for the development of scientific activities. This situation gave a new impetus to Favorsky's creative talents and revealed them in full brilliance. Side by side with new experimental researches aiming at a continuance of the original line of research, in later Favorsky's works there emerged a distinctly fresh trend of an intensely practical nature in response to urgent demands of the modern Russian industry.

The significance of the scientific studies of Favorsky for the synthesis of rubber have been already pointed out. But, prior to 1917, Favorsky himself had no personal dealings with rubber synthesis as such. Now he approached directly this important problem.

As is known, by the Lebedeff's process the synthetic rubber is made from divinyl, derived, in its turn, from ethyl alcohol, for the production of which starch is employed. Besides this, the composition of divinyl rubber somewhat differs from the natural material, which is a polymer not of divinyl, but of its methyl derivative—isoprene.

As was mentioned previously, the synthesis of isoprene has been realized in Germany by Merling, who applied Favorsky's reaction of condensation of acetone with phenylacetylene to acetylene itself, obtaining with the aid of sodium amide the dimethylacetylenylcarbinol, then passing from it by hydration to dimethylvinylcarbinol, and through dehydration of the latter to isoprene.

This method found no favour in industry on account of the unsatisfactory progress of the two stages of the process.

Favorsky subjected the whole process to a minute examination, paying special attention to these two stages. His investigation revealed that, provided certain conditions are observed, by using in place of expensive sodium amide the much cheaper and easily reclaimable potassium hydroxide, it is possible to increase the yield of dimethylacetylenylcarbinol more than twofold. As regards the reduction of the latter to dimethylvinylcarbinol, it should be noted that electrolytic reduction leads, under one set of conditions, as seen earlier, to a mixture of terpenes, under the other conditions, gives almost quantitative yield of dimethylvinylcarbinol. The remaining stages of the process of producing isoprene had already been worked out. The usual sodium polymerization of such

1834

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an isoprene gave from 95 per cent. to 99 per cent. yield of synthetic rubber, which in its properties was closely related to the divinyl and natural rubbers; the adhesion power of bonding agents made from it was an improvement on those of the latter. Thus, the synthesis of rubber from isoprene as evolved by Favorsky is much simpler from the technical standpoint and appreciably cheaper than Merling's process.

There still remained the problem of synthesizing the acetone as a raw material.

Although this synthesis has been realized, not by Favorsky himself, but by his associate Professor Platonoff, it was based on Favorsky's earlier studies, having acetylene as the initial material. Thus, the necessary acetone, in addition to obtaining it from the dry distillation of wood or by the process of acetone-butyl fermentation, may be produced from acetylene either directly by the contact method according to the equation:—

$$2CH \equiv CH + 3H_2O \longrightarrow H_2 + CO_2 + CH_3 - CO - CH_3$$

or indirectly through acetic acid. Under the action of water vapour on acetylene, the yield of acetone approaches very closely the quantitative value.

Hence it is readily seen that the rate of progress in the manufacture of isoprene rubber is directly dependent on the quantity of acetylene available. Thus, the future belongs to this type of rubber, since ever-growing resources of electrical energy in the leading industrial countries are bound to result in the great abundance of cheap calcium carbide as a source of acetylene, and the production of the latter from methane promises to render its resources still more vast.

Equally important are Favorsky's works on the methods of synthesis of vinyl ethers of alcohols, and other oxy-derivatives, which have been mentioned previously. This synthesis, based on Favorsky's earlier studies, has been adopted on an industrial scale in various countries, but its practice has been associated with the application of very complicated technique and costly catalytic agents. Of late, Favorsky, together with Shostakovsky, have succeeded to so simplify and reduce the cost of this synthesis, that with the availability of cheap acetylene and alcohol, the vinyl ethers can be obtained at very low cost in great quantity.

Having regard to the vast scope of vinyl ethers in the technology of plastics, there have recently been set up in Russia several research groups, under the general direction of Favorsky, with the object of working out the best methods and fields for their application, the most interesting aspects of which will be discussed in due course.

Protective Anti-corrosive Coatings

Corrosion-proof insulation in many cases should possess resistance to intermittent action of acids and strong alkalis as well as to relatively high temperatures; at the same time the process of applying the protective coating to the surface of an object under the treatment should be simple. The various coatings based on phenolics and certain other types of widely employed resinous media display in this respect a number of drawbacks, involving a rather complicated equipment for their application and the exercise of precision control.

The anti-corrosive coatings of high protective power, very simple to apply, can be obtained very cheaply from high polymers of acetylene. Of the primary materials of great potentialities in this sphere, divinylacetylene should be accorded the leading place by virtue of the fact that its derivatives are particularly useful either as binders and cements in the preparation of plastic compositions, or as the film-forming agents in the formulation of anti-corrosion varnish systems.

The combination of divinylacetylene varnish as a binder with asbestos as filler (which, under the designation of "Asbovinyl," is now extensively employed in Russia), proves of special advantage.

This composition, in its polymerized

and irreversible stage, is distinguished by the possession of great chemical stability to acids and alkalis. The addition to asbovinyl of from 12 per cent. to 15 per cent. of a solvent imparts to it a high degree of plasticity, rendering it capable of being easily applied to diverse surfaces, including wood, metals and concrete, upon which it forms a tough protective layer of a desired thickness tenaciously adhering to the substrate. The unpolymerized asbovinyl, on heating to 50 degrees or 60 degrees C., yields an excellent material for either pressure, or injection moulding, affording thereby the means of making from it, in addition to tubing and other extruded shapes, articles of the most intricate contour. In the polymerized state, asbovinyl does not soften, is unaffected in any of the commonly known organic solvents, is easily machinable by ordinary tools, polishable, and has the property of elastic deformation. This permits the application of asbovinyl either as a coating medium or as an independent construction material for plant equipment of the chemical and allied industries.

The divinylacetylene varnish composition, as is practised in Russia, is prepared from by-products of the rubber manufacture of the Sovprene type, during the formation of monovinylacetylene, the synthesis of which has already been outlined in the previous section. The unpolymerized divinylacetylene is a colourless viscous mass. Under the action of air, divinylacetylene turns at first into a gelatinous state, then passing into a body of great chemical stability. Divinylacetylene varnishes give films whose moisture impermeability is 15 times higher than that of coatings made of boiled linseed oil. They are also characterized by a splendid covering ability and strong adhesiveness to iron, wood and concrete, although their application without plasticizers and suitable primers to iron surfaces, exposed to the service under the action of light, is not recommended on account of their fairly rapid ageing.

The divinylacetylene varnish is an excellent binder for the various mineral and organic fillers, in particular for asbestos. The varnish composition based on the divinylacetylene, or the so-called ethynol, prior to use, is subjected to tests for chemical stability and a content of high polymers. The varnish is considered as unsuitable if it turns into a gel-like state, and is insoluble in usual solvents (e.g., xylol, benzol, etc.). The coating composition of a normal viscosity should contain up to 70 per cent. of polymers. The standard divinylacetylene varnish has a lower viscosity in comparison with the ethynol, and on setting contracts to a lesser degree.

Two grades of asbestos, duly defibrated, are used in the production of asbovinyl: (i) the chrysothyl variety and (ii) the anthophyllite (acid-proof) asbestos. The chrysothyl grade is employed for making asbovinyl compositions designed for service in weak acid and alkali media. The anthophyllite asbestos, having a shorter fibre structure, is applicable for coatings which have to function under more severe conditions. Besides asbestos, the different organic fibrous materials, such as wood flour, linter, cotton and paper waste, and the like may serve as fillers.

The preparation of asbovinyl mass can best be carried out in vacuum-mixers. The usual procedure is to introduce into the mixer, in several small lots, the divinylacetylene varnish in its initial or ethynol stage, together with the required quantity of the suitable asbestos. The duration of the mixing operation may fluctuate from one hour to 1½ hours, depending on the viscosity of the varnish and also on the proportion of polymers and their ratio to the filler.

The chrysothyl grade of asbestos is characterized by a good adsorption property as compared to that of the anthophyllite variety, and for this reason the quantity of the chrysothyl asbestos required for identical purposes is somewhat smaller than the amount of the anthophyllite grade.

For example, in the making of tubing, for 1 part by weight of the varnish base there is used from 1.4 to 1.45 parts by

weight of the chrysothyl asbestos, as against from 1.5 to 1.6 parts by weight of the anthophyllite asbestos. For protective coatings applied to various apparatus and reinforced concrete structures, a good formulation is to employ for 1 part by weight of the varnish base from 1.3 to 1.35 parts by weight of the chrysothyl asbestos, or 1.4 to 1.45 parts by weight of the anthophyllite grade.

From the mixer the homogenized asbovinyl mass is discharged into steel drums, the operation requiring the wearing by workmen of gas masks on account of the intense evaporation of solvent. The upper surface of the asbovinyl mass, coated with two or three layers of the ethynol varnish to prevent its drying out due to the loss of solvent, is then hermetically sealed with a steel lid, whose seams are also treated with the asbovinyl. For keeping in a long storage or during the transport of the asbovinyl, it is desirable to coat the inner surface of the steel drum with a thick layer of the concentrated divinylacetylene varnish with the object of forming a film envelope over the whole mass within the container, thus preventing it from drying. The asbovinyl composition, depending on the proportion of solvent and the time of the year, may be safely kept from one to six months without its deterioration.

Prior to the application of asbovinyl to steel structures, the surface of the latter should be carefully cleaned from oxides and degreased, and the surfaces of wood and concrete must be dried and free from dust. The most suitable preparation of steel surfaces is by means of a sand-blast apparatus, although there should not be excluded the possibility of the chemical treatment of the surface by acid pickling with subsequent neutralization. The surface of the plant equipment made of the concrete, which has been in use for chemical processing, should, prior to the lining with the asbovinyl, be not only dustless and dry, but also decontaminated from all the traces of products retained in the outer layers of the concrete. In this case, the most rational way would be the relining with the new layer.

In the treatment of the surface the first operation is that of applying a primer consisting of the divinylacetylene varnish mixed together with the asbestos flour as filler, which is followed by the application of the asbovinyl composition, usually in two layers, each from 5 to 6 mm. in thickness. The second layer of the asbovinyl mass is applied after the air drying of the first layer for about two or three days.

The conversion of the applied asbovinyl lining, that is, its hardening, may be conducted either at normal or the elevated temperature. The natural polymerization, depending on the thickness of the applied asbovinyl layer, is a slow process, and, therefore, to accelerate the polymerization reaction the latter should be performed at the elevated temperatures ranging from 50 degrees to 130 degrees C.

According to data of the Experimental Pilot Plant in Moscow, the following thermal regime for the polymerization can be recommended:—

Temperature, °C.	Time, hours	Temperature, °C.	Time, hours
55–60	2	95–100	4
60–65	2	100–105	4
65–70	2	105–110	4
70–75	2	110–115	4
75–80	2	115–120	3
85–90	3	120–125	3
90–95	3	125– 30	3

On the termination of the polymerization process, the temperature should be gradually lowered to the ambient level over a period from 9 to 10 hours. The foregoing procedure has been carried out on an asbovinyl lining 12 mm. thick in a reaction chamber.

The application of high-frequency electro-thermics to the treatment of compositions of the asbovinyl type should give very interesting results, as the contraction of such a material is negligible.

When the setting operation has been completed, the asbovinyl lining is carefully examined for blisters and holes or other defects, and is finally coated with the ethynol varnish. The continuity of the finished surface is then tested by any suitable method.

Physical and Chemical Properties of Asbovinyl.

Specific gravity (asbestos to varnish = 1.4 : 1)	1.6–1.5
Tensile strength	130–190 kg./cm.²
Frost stability in liquid air	Complete
Heat stability	180°–205°C.
Resistance to:—	
HCl all concentrations in cold ..	Stable
HCl all concentrations at 90°C. ..	Stable
H_2SO_4 5 per cent. to 70 per cent.	Stable
HNO_3 up to 15 per cent.	Stable
HNO_3 over 23 per cent.	Affected
Organic acids	Stable
Caustic alkalis up to 50 per cent.	Stable
Hydrochloric gas	Stable
Organic solvents	Stable

A relatively high mechanical strength of the asbovinyl affords its application not only as a protective corrosion-resistant material for the lining of the various plant equipment, but as an independent construction material as well.

The rigorous tests on the mechanical strength and the corrosion-resistance of tubings and fittings made of the asbovinyl at the Experimental Works in Moscow have yielded perfectly satisfactory results, so that now the Chief Administration of the Plastics Industry in Russia has adopted its production on an industrial scale.

(To be continued)

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TESTING MACHINE FOR PLASTIC BEARINGS

(continued from page 188)

tance of 20 ins. from the shaft centre above the beam. Differences in reading indicated variations from the horizontal position of the beam under the influence of torque. The half sum of both readings represented alteration in vertical position under the influence of bearing load.

The fluid lubricant was fed to the test bearing by gear pumps, all conduits being equipped with pressure gauges and volume meters. Heating devices with automatic control, and filters, were also provided.

Determination of Errors

The indications of the speedometer were checked by a revolution counter and a stop watch. For a large number of measurements the read variations were up to 2 per cent. of the measured value. The pressure gauge for measuring the bearing load was calibrated by means of a testing device, whereby variations up to 5 per cent. of the nominal value were found.

When measuring the torque, errors could occur, through moments, when the axis of the upper rolling arc did not coincide with the axis of the shaft, and the rolling resistance between the rolling surfaces. By means of additional weight on the beam, these errors could be determined: During 200 measurements, the additional weights were indicated as too great in 11 cases, correct in seven cases, and, in 182 cases, as too low. When the dynamometers were removed from the beam and the same test was carried out with the dynamometers alone, errors of similar magnitude were found, i.e., for $\frac{1}{2}$ maximum load up to ± 3 per cent., for $\frac{1}{3}$ maximum load up to ± 5 per cent. This showed that the rolling resistances were so small, that no errors worth mentioning were caused in measured torque. From the measured temperatures it was intended to deduce up to what bearing-surface temperatures the plastic material tested could be used. These temperatures were between 70 to 90 degrees C., and errors of 2 to 3 per cent. were neglected. Errors in the absolute value of the temperature were, therefore, not critical, and it was sufficient to compare recorded readings with a suitable mercury thermometer. Oil temperatures were checked by a mercury thermometer built-in at the side of the thermocouple. The differences between the two instruments were up to ± 3.5 per cent. of the measured value.

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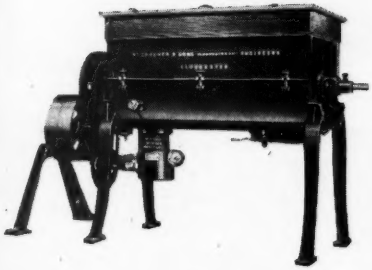

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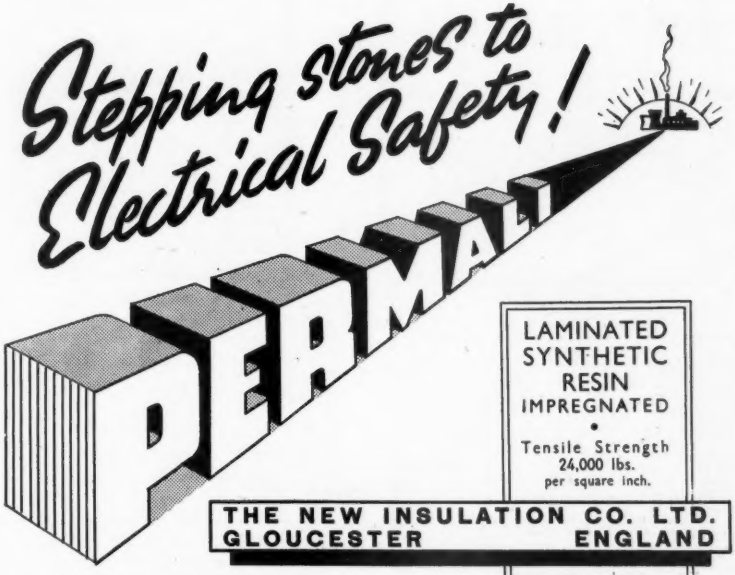

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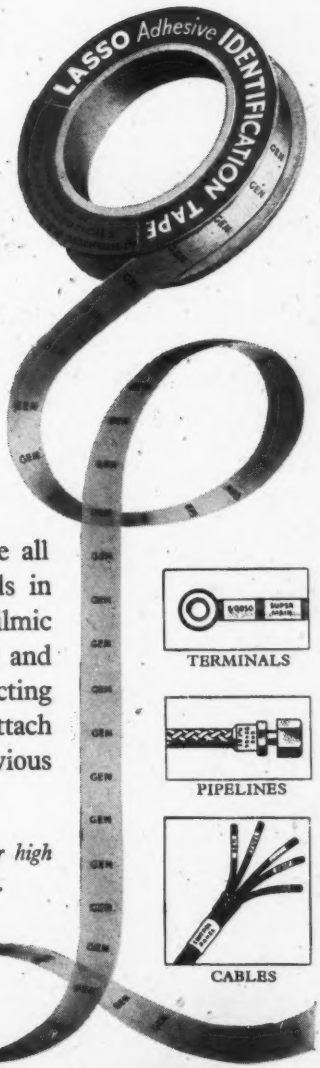

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APRIL, 1945. Vol. IX. No. 95 **Plastics** ONE SHILLING & SIXPENCE

Dwellers round the mountain-locked Lake Titicaca, having no timber for their boats, fashioned them of sticks and reeds, rigging sails of plaited straw. So through all the ages man has had to seek his materials before his creative ideas could take shape.

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